PHYSIOLOGICAL ESSAYS AND OBSERVATIONS,

BY

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OBSERVATIONS

AND

ESSAYS

ON

PHYSIOLOGICAL

CONTENTS.

ESSAY I.

Page

Of the DIVISIONS of PULSES. 3

ESSAY II.

Of MENSTRUATION. 33

ESSAY III.

Of MEASURING PROPORTIONAL QUANTITIES of HEAT. 95

ESSAY IV.

Of INSALUTARY CONSTITUTIONS of the AIR, from a Defect of WINDS of the higher Degrees. 123

CONTENTS.

ESSAY I.

Page

Of the Divisions of Pulses. 3

ESSAY II.

Of Menstruation. 33

ESSAY III.

Of Measuring Proportional Quantities of Heat. 95

ESSAY IV.

Of Involuntary Constitutions of the Air, from a Defect of Vitals of the higher Degrees. 153

ESSAY I.

OF THE

DIVISIONS

OF

PULSES.

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ESSAY I.

Of the DIVISIONS of PULSES.

AMONG the various ſigns of diſeaſes, none are more frequently, nor more juſtly, attended to than thoſe ariſing from the pulſe; and though ſuch may be, for the moſt part, inſufficient by themſelves to aſcertain the nature of any diſtemper, yet we can ſeldom, with ſafety, proceed to the cure, without taking ſome indication from the ſtate of the pulſe.

OF the different conjectures which we are enabled to form from the pulſe, the moſt obvious are, the increaſed or diminiſhed velocity of the blood, when either of theſe are in a conſiderable degree; the changes in the action of the heart and arteries, and the comparative force of theſe organs. From the pulſe likewiſe we are frequently enabled

to draw indications relating to the quality of the blood. But thoſe who have been moſt attentive to the ſymptoms of diſeaſes, and are acquainted with the animal œconomy, will judge beſt of what importance an accurate examination of every circumſtance relating to the pulſe muſt be in the practice of medicine.

THE multiplicity of definitions, and the too minute diviſions of pulſes, have, inſtead of perſpicuity, been productive of ſome degree of obſcurity. Many authors have mentioned the GREAT, the STRONG and the FULL pulſe indiſcriminately, though theſe may be eaſily diſtinguiſhed. It is hoped, therefore, that an attempt to correct theſe, with ſome other improprieties and defects in this part of pathology, will not be deemed unſeaſonable.

BELLINI, who hath written explicitly on this ſubject, makes the firſt diviſion to conſiſt of twelve kinds; or of ſix, each having

ing its oppoſite correſponding pulſe: theſe are the PULSUS MAGNUS and PARVUS; FORTIS and DEBILIS; PLENUS and VACUUS; CELER and TARDUS; FREQUENS and RARUS; MOLLIS and DURUS.

SOME of theſe are ſeldom, if ever, expreſſed in Engliſh; for which reaſon they are here, and ſhall be throughout this eſſay, mentioned under Latin names.

WHEN we conſider in what reſpects a pulſe may deviate from its natural ſtate, we ſhall thereby be led to make the firſt great and ſimple diviſion: after which it will be eaſy to conceive what is meant by compounded pulſes.

AN artery may differ from its natural action by being too much, or too little, dilated; or in its pulſations being too frequent or too ſlow.

IT

It is evident that many diviſions may be conceived, from the various dilatations of an artery, independent of the frequency of the pulſations; and likewiſe ſome from the frequency independent of the other. But, in making the firſt and ſimple diviſion, it will be proper to diſtinguiſh, as much as poſſible, theſe different pulſes by the greater or leſs frequency of the pulſations; that is, when the pulſe exceeds, or falls below, its ſtandard number in a given time. The reaſon is evident, when we conſider, that we can be ſure of the number of pulſations; whereas the various degrees of dilatation of an artery cannot be aſcertained with ſuch preciſion as to eſtabliſh accurate diviſions.

It may be obſerved here, that, in mentioning the ſtandard number of pulſations, it is not to be underſtood as if this could be reſtricted to a preciſe number. But if, in a matter ſo delicate, we can come within ſix, eight, or, in ſome people, ten pulſations, it will be ſufficient for all the purpoſes wanted.

As

As a deviation from the natural dilatation of an artery rarely, if ever, happens, at leaſt from an internal morbid cauſe, without the pulſe likewiſe changing from its ſtandard number, we may, from hence, be led to deduce the four following pulſes.

1. WHEN the artery, in its vibration, exceeds its natural dilatation, the number of pulſations being equal to, or falling below, the ſtandard.

2. WHEN the artery falls below its natural dilatation, the number of pulſations being above the ſtandard.

3. WHEN the artery exceeds the ſtandard both in the dilatation and number of pulſations.

4. WHEN it falls below its natural dilatation, the number of pulſations being equal to, or below, the ſtandard.

THE

THE firſt of theſe I call the PULSUS MAGNUS; the ſecond, the PULSUS PARVUS; the third, the PULSUS FORTIS; and the fourth, the PULSUS DEBILIS. The firſt of theſe differs from the ſecond, and is oppoſite to it, both in the dilatation and number of pulſations; and the third differs from the fourth in the ſame reſpects.

THOUGH the differences in the dilatations of the artery, and the differences in the number of pulſations, generally, perhaps always, attend one another; yet, as the former are often wholly undiſtinguiſhable by us, we muſt therefore add to the firſt claſs the PULSUS FREQUENS and RARUS; that is, when the number of pulſations exceeds, or falls below, the ſtandard, while the extenſion of the artery is, to our feeling, unchanged. Could we diſcover the various extenſions of an artery with the ſame accuracy as we can reckon the number of pulſations, theſe two pulſes, the FREQUENS and RARUS, might be neglected.

ALL

All theſe pulſes may be better conceived from the figure *, where *a b*, the diſtance betwixt the parallel lines, expreſſeth the difference betwixt the ſyſtole and diaſtole of the artery in the pulſes deſcribed above: *a c*, the times: and the undulations, diſtinguiſhed by the numerical figures, ſhew the number of pulſations in equal times. From the figure, this claſs of pulſes may be conveniently compared with the mean or natural ſtate of the pulſe.

The reaſon why the PULSUS FORTIS is thus diſtinguiſhed from the PULSUS MAGNUS, will be obvious when we conſider, that, in order to make the artery ſtrike againſt the fingers with vigour, it is not only neceſſary that it exceed its uſual dilatation, but likewiſe that the number of pulſations, in equal times, be increaſed.

We may have a juſt idea of this from a pendulum; for, if the oſcillations of the pen-

* Plate I. Fig. 1.

dulum be wide, but ſlow, theſe correſpond to the PULSUS MAGNUS. But, if the oſcillations of the ſame extent be accelerated, theſe will give a proper idea of the PULSUS FORTIS: for the force with which the pendulum would ſtrike againſt any reſiſting body is increaſed according to the degree of acceleration.

THE PULSUS PARVUS is ſo named from the diminiſhed time of each pulſation, and likewiſe from the vibrations of the artery being more contracted than in a natural ſtate. The PULSUS DEBILIS conſtantly indicates an unnatural weakneſs in the action of the heart. Theſe two pulſes are frequently mentioned indiſcriminately: but, as they may be diſtinguiſhed with eaſe and certainty, and as they correſpond with propriety to the two preceding pulſes, it is hoped that this diviſion will be admitted.

THERE remains another kind of pulſe in this diviſion; this is when the artery, in the ſyſtole, doth not return to its natural ſtate of

of contraction; or rather, when, in the ſyſtole, the diameter remains more extended than it ought. This is the PULSUS PLENUS; and, as it indicates a *plethora*, may properly be termed the plethoric pulſe. In this caſe there ſeems likewiſe to be, for the moſt part, an uncommon dilatation in the diaſtole, and the artery is felt full, ſoft and obtuſe, though its vibrations be feeble. The PULSUS PLENUS is ſo named, not from a great, or ſtrong, vibration of the artery, but from the indication of an unnatural fulneſs in the veſſel.

THIS pulſe is often confounded with the PULSUS MAGNUS, as the learned M. de Haller obſerves; and yet they may without difficulty be diſtinguiſhed: for the vibration of the artery, in the PULSUS PLENUS, is weak and confined, though the artery be really full and extended: whereas, in the PULSUS MAGNUS, the vibration is greater and more free. In the PULSUS

PLENUS, the artery is frequently found to recover its elaſticity by bleeding.

SOME authors, in the diviſion of regular pulſes, ſeem to think that each ought to have an oppoſite correſponding one. Thus, having deſcribed the PULSUS PLENUS, we find likewiſe a PULSUS VACUUS mentioned. But, upon conſidering the matter with great attention, I preſume to think that there can be no ſuch pulſe diſtinct from thoſe already deſcribed *.

FOR

* The Greeks, among other pulſes, mention the Σφυγμὸς κένος. But it appears, that they did not underſtand by this, a low or empty pulſe, as contradiſtinguiſhed from the *pulſus plenus*. Thus Aretæus, in deſcribing a beginning peripneumony, Lib. II. de acut. morb. Σφυγμοὶ τὰ πρῶτα μεγάλοι, κενοὶ, &c. Now the *pulſus magnus* and *pulſus vacuus* can never be ſuppoſed to coincide, in the ſenſe in which the moderns underſtand the latter. By Σφυγμὸς κένος nothing more can be meant than a ſoft pulſe, yielding readily to the touch, the artery feeling as if it were full of air rather than blood; ſuch as that deſcribed by Galen in the ſame diſeaſe. ὁ δὴ περιπνευμονικῶν (σφυγμὸς) μέγας ἐστὶ καὶ κυματώδές τι ἔχων ἅμα καὶ ἀμυδρὸς καὶ μαλακὸς ὁμοίως τῷ τῶν λιθαργικῶν. &c. Iſagog. pulſuum. The *pulſus vacuus* then of the ancients ſeems to have been the *pulſus plenus* of the moderns.

For, if we ſuppoſe the greateſt degree of inanition, without deſtroying the action of the heart altogether, the pulſe, in this caſe, will properly come under the denomination, either of the PULSUS PARVUS, or of the PULSUS DEBILIS, though, before this evacuation, it had been a PULSUS PLENUS.

It hath been thought, in making theſe diſtinctions, that a pulſe, which is defined from exceſs, whether in the quantity of blood, or in the action of the heart, ought to have an oppoſite pulſe from an oppoſite cauſe *.

But we may obſerve, that an artery can admit of more diviſions from its dilatations than from its contracted ſtate: for the arteries are not ſuppoſed to contract beyond the ſyſtole, which is their natural ſtate, or that which

* Cum igitur unaquæque res dupliciter a naturali ſtatu recedere poſſit, vel deficiendo, vel excedendo; omnis pulſus, a mediocri deficiens, vel excedens, appellabitur non naturalis. Bellin. de pulſ.

which they aſſume when they ſuffer no violence. But their diameters may be extended beyond their natural degree, in the ſyſtole, as well as in the diaſtole, as is the caſe of a *plethora*; and, in ſo far, an artery may deviate from nature in more reſpects by exceſs than by defect.

It hath been obſerved, that the PULSUS MAGNUS and the PULSUS FORTIS denote much blood *. When theſe are underſtood as natural pulſes, they may indicate that the veſſels contain a ſufficient quantity. But, when they indicate a morbid ſtate of the body, they are the reſult of the quality, rather than of the quantity of the blood. It is true, that, in inflamatory caſes, the diſeaſe may be moderated by bleeding, and is often cured by repeating that evacuation; but, in theſe caſes, as the fever abates, the blood is obſerved to change its quality; and, when the diſeaſe is removed, the patient is found to

* Id. ibid.—Boerhaave inſtitut. § 959. 961.

to be weakened in proportion to the quantity of blood loſt. But, in true plethoric caſes, one acquires ſtrength and alacrity from the evacuation; which is the CRITERION of a true *plethora*, or a ſign that the morbid cauſe lies ſolely in the quantity of blood.

THE PULSUS CELER and PULSUS TARDUS, are not ſuppoſed to relate to an increaſed or diminiſhed number of pulſations in a given time; but to the artery receding more quickly, or ſlowly, from the fingers in feeling the pulſe. Theſe pulſes ſeem not to differ from the MOLLIS and DURUS, but might be better expreſſed by OBTUSUS and ACUTUS, without any further diſtinction.

UPON the whole, the primary or moſt ſimple diviſion of pulſes conſiſts of ſeven kinds, *viz.* the PULSUS MAGNUS and PARVUS; FORTIS and DEBILIS; FREQUENS and RARUS; and the PULSUS PLENUS or PLETHORICUS.

ALL

ALL theſe pulſes, or the moſt part of them, are ſometimes to be met with in the different ſtages of the ſame diſeaſe; but there are other diſeaſes to which particular pulſes are more peculiar. The PULSUS MAGNUS frequently attends a STUPOR, COMA, VERTIGO, LETHARGY, and other diſorders of the head, where there is little or no fever. It is likewiſe not uncommon in HYPOCONDRIACISM and MELANCHOLY, and often preſages a MANIA. In this reſpect the hypocondriacal diſorders, in men, generally differ from the hyſterical; as the latter are commonly attended with the PULSUS PARVUS: and, in general, the PULSUS MAGNUS is rarely to be met with in women; their manner of life and habit of body rendering the ſex more liable to the oppoſite pulſe.

THE PULSUS PARVUS is to be found in moſt part of fevers, either through the whole diſeaſe, or in ſome of the ſtages. Towards the end of inflamatory fevers, this

pulſe

pulſe is an unfavourable ſign. It is a pathognomic ſign in hectic fevers. The low, malignant, bilious and peſtilential fevers are commonly attended with this pulſe throughout. It is almoſt a conſtant concomitant of the PHTHISIS PULMONALIS. It is likewiſe common with women, who have weak nerves, and who are ſubject to ſudden tremors, palpitations, and to the well known tribe of hyſterical ſymptoms. In general, this pulſe is more frequently met with than any other ariſing from morbid cauſes.

THE PULSUS FORTIS commonly introduceth inflammatory fevers, eſpecially thoſe proceeding from inflammations in the THORAX. This pulſe, more than any other, indicates bleeding; being a cerain indication of an increaſed velocity in the circulation, and frequently of a coheſive ſtate of the blood. But though, in inflammatory fevers, attended with this ſymptom, we bleed with ſafety and advantage; yet there are fevers, in ſome periods of which we meet

with this pulſe, and then ought to be cautious of bleeding. This is the caſe in fevers of the remitting and intermitting kind, where the PULSUS FORTIS precedes critical ſweats.

THE PULSUS DEBILIS always indicates a diminiſhed velocity in the circulation, and is, of all kinds, the moſt dangerous; and the more ſo, if, with the diminiſhed extenſion of the artery, the pulſe fall conſiderably below its ſtandard number: for the blood, not being ſufficiently agitated, ſoon loſeth its natural texture. This pulſe is frequently unequal, and interrupted *.

I. S. a man aged about fifty five years, of a ſlow ſpeech, and ſlow in all his motions, whoſe profeſſion and genius confined him to mechanical ſtudies, and arithmetical computations,

* Qui pulſus has malignitatis notas omnes conjunctas habet, certum lethi ſignum eſt; neque talem hominem evaſiſſe exemplum extat. Haller in inſtitut. § 966.

computations *, fell into a ſlow fever, attended with a deep STUPOR, from which the moſt ſtimulating medicines were inſufficient to rouſe him. His pulſe, which, for the firſt day or two, had been ſtrong and frequent, for thirteen days afterwards, in the courſe of the diſeaſe, did not exceed forty eight in a minute; which, for ſuch a length of time, was the ſloweſt pulſe I had ever felt. Though the pulſations were not very ſmall, I was informed by the ſurgeon, that they were ſomewhat ſmaller than in a natural ſtate; and that, in health, his pulſe uſed to beat about ſixty five in a minute.

ABOUT two days before death, his pulſe became lower and more frequent; and both it and other ſymptoms ſoon gave evidence of a reſolved ſtate of the blood.

* Theſe characters are particularly mentioned, as I have frequently obſerved that people of this conſtitution are ſubject to diſorders of the head, attended with a ſlow pulſe.

SUPPOSING then the artery, when beating ſo ſlow, to have loſt, in the diaſtole, one tenth of its natural diameter; and that, in the ſyſtole, there remained ſeven tenths; then was the velocity of the blood in the diſeaſe to that when in health, as twenty-three to fifty one. Had there been no difference in the dilatation of the artery, the proportion, depending only on the number of pulſations, would have been as eight to eleven. But though we ſuppoſe the artery to have loſt only ſo much of its extenſion as, with the diminiſhed number of pulſations, to have made the circulation in the diſeaſe, to that in health, as thirty to fifty one; there is reaſon to believe that even this would have been inſufficient to preſerve the proper texture of the blood for any conſiderable time.

IN this caſe, we have an example of the pulſe paſſing from a natural ſtate to the PULSUS FORTIS, from that to the PULSUS DEBILIS, and from that again to the PULSUS PARVUS. It may be obſerved that,

that, though the number of pulſations in the PULSUS PARVUS may ſometimes balance the loſs of dilatation in the artery, ſo as to preſerve the ſame degree of velocity in the circulation; yet this pulſe ſeems always to indicate, either the weakneſs, or the labour and difficult action of the moving power.

THE PULSUS PLENUS is frequently met with in women, when the periodical return of the MENSTRUA approacheth; particularly in thoſe women who menſtruate with difficulty. This pulſe is likewiſe to be found in people of a thin habit, and pale complexion, ſubject to hemorrhages, whether from the noſe, lungs, or hemorrhoidal veſſels.

THE PULSUS PLENUS, not being diſtinguiſhed by any increaſe or diminution of pulſations, may be attended either with a quick, or ſlow circulation, and therefore could not be well expreſſed in a figure.

HAVING

HAVING thus propoſed the great or primary diviſion, it will be eaſy to refer the reſt of the pulſes to it, ſo as to diſtinguiſh what hath been called the compounded pulſes. Thus, the MOLLIS and DURUS, CELER and TARDUS, ACUTUS and OBTUSUS *, DICROTOS, INTERMITTENS or INTERCURRENS, may fall in with any of the pulſes deſcribed above.

MANY names have been affixed to pulſes, which are merely figurative, and may well be diſpenſed with. Thus, the PULSUS FORMICANS, or fluttering pulſe, is nothing but the

* The pulſes *durus* and *mollis*, *celer* and *tardus*, *acutus* and *obtuſus*, which may be conſidered as not differing from one another, may be conceived from figure 2. plate 1. where, if *a c* repreſent the ſurface of an artery in the diaſtole, the numbers 1, 2, 3, will give an idea of the *durus*, *celer*, or *acutus*; and 4, 5, 6, of the *mollis*, *tardus*, or *obtuſus*. Theſe pulſes, being diſtinguiſhed by the proportions of time betwixt the *ſyſtole* and the *diaſtole* in each pulſation, may coincide with any of the pulſes in the firſt diviſion, which are all diſtinguiſhed, either by the velocity of the pulſe, or by the dilatation of the artery differing from a natural ſtate, or by both theſe together; to which two diſtinctions the three pulſes here deſcribed have no reference.

the PULSUS PARVUS in its loweſt ſtate; the VERMICULARIS is the PULSUS DEBILIS; the PULSUS UNDOSUS is that kind which is ſaid to be felt fuller under one finger than another; but which cannot be owing to any difference in ſo ſmall a portion of an artery, but either to the greater preſſure of one finger than of another, or to one part of the artery lying more ſuperficial, or deeper, than another. This kind, therefore, as well as the PULSUS MYURUS and CAPRIZANS, ſeem to be only a deception. But every kind of pulſe, having ſome reſemblance to a wave may, without impropriety, be termed UNDOSUS. Now, as the idea of ſome of theſe pulſes appears to have ariſen from an unequal application of the fingers to the radial artery, the method of feeling pulſes to the greateſt advantage, may not be unworthy the attention of young practitioners.

AN artery being but a very little more or leſs ſuperficial gives the idea of a ſtrong, or of a weak pulſe: hence it is, that, in the ſame

ſame perſon, we often feel the pulſe in one arm different from that in the other; and Boerhaave juſtly obſerves that the pulſe is frequently deceitful in fat people *.

When the pulſe is not diſtinct, the moſt certain method of judging of it is, to preſs the fingers ſo much that the circulation in the artery may ſeem to be ſtopped; and, raiſing the fingers gradually, let the touch at laſt become quite ſuperficial. By this method we may judge with more certainty of the action of the artery, than by an uniform preſſure of the fingers: and as, in feeling the pulſe, when our fingers are cold, we are apt to believe the pulſe to be weaker than it really is, it is of ſome conſequence to preſerve the natural heat of the hand.

It hath been believed, that there is an exact proportion between the quickneſs of the circulation and animal heat; or that the

* Boerhaave inſtitut. § 960.

the degree of heat increaſeth in proportion to the attrition, and *momentum* of the blood; and the pulſe, being the only indication of changes in the circulation, hath likewiſe been believed to indicate greater or leſs degrees of animal heat *.

Whether thoſe, with whom the natural *momentum* of the blood is greateſt, be likewiſe poſſeſſed of the greateſt degree of vital heat, in the ſenſe in which the ancients underſtood vital or internal heat, I ſhall not pretend to determine. But we now know that nothing more was underſtood by this, than the principle of life, in an higher, or lower degree, independent of real or abſolute heat.

But though the conſtitutions of animal bodies be ſuppoſed to be, *cæteris paribus*, better, the greater the natural force of the moving power is, this hath no relation with abſolute heat, or animal heat, taken in a

* Boerhaave Inſtitut. § 968.

literal ſenſe, which doth not appear from obſervation to depend upon the *momentum* of the blood, attrition, or the reſiſtance occaſioned by the denſity of the fluids; for it is known from experiments, that the heat of the human body is frequently above the ſtandard, while the *momentum* of the fluids is conſiderably below its natural ſtate; particularly when the texture of the blood is ſo much reſolved that we have reaſon to believe the reſiſtance at the capillaries is leſs than uſual. This is, for the moſt part, found to be the caſe in the laſt ſtage of putrid, bilious, and peſtilential fevers.

Professor de Haen obſerves, that the *momentum* of the blood, or attrition, is ſo far from being the cauſe of animal heat, that, even after the motion of the fluids hath ceaſed altogether, heat hath been found to increaſe; and accordingly obſerved the thermometer to riſe when applied to human bodies immediately after death. When the thermometer is ſuddenly expoſed to heat of a conſiderable

ſiderable degree, the mercury is obſerved to fall a little, and then to riſe. The glaſs ball of the inſtrument being ſomewhat enlarged by the heat, before it hath had time to act upon the mercury, is the cauſe of this deſcent. For the ſame reaſon, when the inſtrument begins to cool, the ball is contracted before the mercury hath loſt any degree of its rarefaction, and, conſequently, it will aſcend in the tube, even while the ambient heat diminiſheth *. This experiment therefore, meant to prove the increaſe of heat after death, would have been more ſatisfactory, had the learned author ſignified that he was aware of theſe effects of heat and cold on the thermometer.

It is not improbable that heat, whether of itſelf a poſitive body, or merely the modification of other bodies, may be poſſeſſed of different qualities, as well as it is ſuſcep-

* This hath been aſcertained by various experiments, particularly by thoſe of Bulfinger. Comm. Acad. Petropolitan. vol. 3. p. 242.

tible of different degrees. Thoſe who have been accuſtomed to touch ſick people, eſpecially when under the ſpecies of fevers laſt mentioned, muſt have been ſenſible of a pungent heat, affecting the fingers in a manner different from the heat of the body when in health, though then raiſed to an high degree by exerciſe, or otherwiſe. Galen was particularly attentive to this circumſtance, and deſcribes the difference betwixt a vital or natural, and a morbid heat, as a ſymptom of great conſequence *.

THE pulſes hitherto deſcribed are meant as indicating a morbid ſtate of the body, and are ſuppoſed to refer to every perſon's natural pulſe; for what is a natural pulſe with one perſon, may indicate a morbid ſtate

* Siquidem eſt ſubſtantia caloris genuini (τῦ ἐμφύτυ θερμῦ) temperata; ignea adventitii (τῦ ἐπικτήτυ.) Sanorum enim calor vaporoſus eſt, blandus, et ad tactum familiaris, gratuſque, nihil quod moleſtum, aſperumve, et mordax ſit, habens. Contra febricitantium calor, præſertim ſi febris ſit hectica, aut ex humorum orta putredine, acris, ingratuſque eſt, mordax etiam, ac tangentem manum pertundens, atque pungens. Galen in Hippocrat. Aphoriſm. 14. ſect. 1.

ſtate of the body with another. One of a gigantic ſize, and of an athletic habit, hath not naturally the ſame kind of pulſe with a dwarf; nor can either of theſe be ſuppoſed to have a pulſe equal to that of the other, without a diſeaſe; and we often meet with people, ſeemingly of the ſame habit and conſtitution, who have nevertheleſs pulſes of different kinds; from which it appears of what advantage it is to be acquainted with the conſtitutions of people in health, to be able to judge with greater certainty of the nature of diſeaſes.

But, when one is ſaid to have naturally a great or little, a ſtrong or weak, a quick or ſlow pulſe, theſe are ſuppoſed to refer to an univerſal mean pulſe; an idea of which every phyſician muſt form to himſelf, from a frequent examination of a variety of pulſes. Thus, when Boerhaave ſays that the pulſe which is ſtrong, great and ſlow, is, of all kinds, the beſt, we muſt underſtand this as referred to an univerſal mean pulſe, or the

expreſſion

expreſſion can have no meaning: for where any perſon's pulſe is ſaid to be great, ſtrong and ſlow, with reſpect to the mean or natural ſtate of that perſon's pulſe, then are we to underſtand theſe characters of the pulſe as indicating a morbid ſtate of the body.

ESSAY II.

OF

MENSTRUATION.

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THE monthly evacuations of women being one of the moſt curious circumſtances in the animal œconomy, ſeveral learned phyſiologiſts have exerted themſelves to account for them. Some would aſcribe them wholly to a periodical addition of blood, without admitting any change in its quality, while others would have them proceed from a fermentation, or ſome other change in the fluids.

DOCTOR Freind, among others, having treated this ſubject with his uſual elegance and perſpicuity, and his hypotheſis having been generally adopted, I ſhall here examine, (though with the regard that is due to the memory of ſo reſpectable an author,) whether his

method of accounting for the menſes by mechanical laws be ſufficient, and agreeable to the operations of nature; or what other principles can aſſiſt us in explaining this branch of the animal œconomy.

I. A MONTHLY PLETHORA, ariſing from a defective perſpiration, is the ground work of Doctor Freind's hypotheſis. But it doth not ſufficiently appear, whether the learned author means that a greater proportion of blood, and a leſs proportion of perſpirable matter is generated in women than in men; or, ſuppoſing the proportion to be the ſame in both, whether the diſcharge by the pores of the ſkin be leſs in the female ſex than in the male.

THAT this laſt was Doctor Freind's opinion, appears more probable from ſeveral paſſages in his *Emmenologia*, particularly where he quotes the fifty ſecond aphoriſm, ſect. 1. of Sanctorius, in ſupport of his own hypotheſis, *viz.* that want of ſtrength is a cauſe of

of a defective perſpiration; that the force of the heart in females, being leſs than in males, is inſufficient to diſcharge all the perſpirable fluid, and that the quantity retained proves the cauſe of a periodical PLETHORA *.

ACCORDING to Doctor Freind, the quantity of the monthly diſcharge may amount to about twenty ounces †. Hence one thirtieth part of this quantity, or even of two pounds, every day, comes to be but an inconſiderable diminution of perſpiration, and will ſufficiently account for the monthly PLETHORA ‡.

* Quid enim eſt robur, niſi vis illa quæ a ſanguine et ſpiritibus in membra derivatur? ea vero quomodo derivari poteſt, niſi cor validius contrahatur?—Ad hunc modum a viribus imbecillis orietur perſpirationis defectus. Emmenol. cap. 3.

† According to others, particularly Sydenham, it is much leſs. Aſtruc makes it extend from 8 to 16 oz. De Haen from 4 to 10, or 11.

‡ Igitur ſatis eſſet ſanguinis plethorici ut lib. 1. ¾ quæ vulgaris eſt catameniorum menſura, ſingulis menſibus effundi poſſit, ſi non ultra 5 ½ drachm. quod perpaucillum eſt, pe rdiem imminueretur perſpiratio. Emmenol. cap. 7.

THAT there is a redundance of blood every month is abundantly evident. But that the cauſe of this PLETHORA is a deficient perſpiration, may be called in queſtion for the following reaſons.

1. THE quantity of perſpirable matter retained in the blood every day, according to the above computation, being only 6. 4 drachms, cannot be ſuppoſed to produce bad conſequences, provided it be not retained in the body many days. But, if this quantity goes on accumulating to two pounds, or nearly ſo, in thirty days, it cannot fail to have bad effects, long before the expiration of that time, according to all the accounts we have of obſtructed perſpiration. Sanctorius every where declares the danger of a ſtopped perſpiration, and ſays, that twelve ounces, (which is little more than one half of the above-mentioned quantity,) retained in the body for twenty four hours only, muſt either be diſcharged by ſome ſenſible,

ſible, and critical evacuation, or quickly occaſion a diſeaſe *.

2. If the final cauſe of the PLETHORA in women be the nutrition of the fœtus, as hath been generally believed, it is not probable that nature, in order to attain this end, would have recourſe to a real defect, that is, the want of power to expel an excrementitious fluid. Nor can we well believe that this ſame fluid, which is found to be ſo hurtful to the body when retained in it, can be the ſource of milk, a nouriſhment ſo neceſſary for children after birth.

3. If Doctor Freind conſiders the menſes as the effect of diminiſhed perſpiration, it might naturally have been expected, that, in order to make one part of his hypotheſis ſquare with another, the learned author would have ſuppoſed, with ſome others, that this monthly evacuation is the means of purging the blood; whereas he ſays that the menſtrual

* Sect. 14. aphor. 31. and 37.

menſtrual fluid is the pureſt, and moſt fragrant arterial blood *.

4. When women come to that term of life, in which the menſes ceaſe, as the vital functions then become weaker, the power of carrying on perſpiration muſt likewiſe diminiſh: this both Sanctorius and Dodart found by ſtatical experiments †.

In what manner then can we ſuppoſe the perſpirable matter to be diſpoſed of, at a period of life when an outlet ought to be more neceſſary than ever? If it be ſaid, by ſtool, or urine; why not by theſe channels before? If it be not carried off at all; then ought women, in the latter part of life, to increaſe in weight at the rate of 16, or 20 ounces every month: which is ſo far from being true,

* Neque enim in ſanis ſanguis ille qui ejicitur impurus eſt, aut vitioſus, ſed optimus et fragrantiſſimus.

† Senſim enim ab ætate conſtanti et integra, ad ætatis flexum minuitur perſpiratio, et quo magis ingraveſcit ætas, eo minor fit evacuatio. Dodart Medicin. Stat. Gall.

true, that, for the moſt part, they diminiſh after that period.

We are told of women, in the moſt northern inhabited latitudes, who do not menſtruate in winter, having that evacuation only during the ſummer *. According to Doctor Freind's theory, it ought to be quite otherwiſe; ſince it is found, by ſtatical experiments, that we perſpire more in ſummer than in winter; and, in theſe cold climates, the difference of perſpiration, in the two oppoſite ſeaſons, muſt be conſiderable.

It would therefore ſeem prepoſterous to ſuppoſe, that the paſſages by which the veſſels uſed to unload themſelves ſhould be ſhut up, when the neceſſity for the diſcharge increaſeth.

Upon the whole, ſince a greater quantity of blood is neceſſary in females than is ſufficient for nouriſhment, it appears more analogous

* Linnæi Flor. Lappon. p. 324.

logous to the other operations of nature, to have endued them with a greater power of making blood than the males: and, as a larger proportion of blood is generated, the perſpirable, as well as all the ſenſible evacuations, muſt be proportionally leſs.

II. THE next thing to be conſidered is a PLETHORA, and its effects on the circulation. Doctor Freind obſerves that, in a PLETHORA, the animal ſpirits are increaſed, by which means the action of the heart becomes ſtronger; and, in conſequence of that, the velocity of the blood is likewiſe increaſed.

THAT there is always an addition of animal ſpirits, upon an increaſe of blood, may be doubted: for thoſe, who labour under a PLETHORA, ſeem not to gain, but rather to loſe animal ſpirits; for, in this ſtate, it is commonly obſerved that we become more ſluggiſh, and not more active.

THAT

That the ſecretions may be regularly carried on, there ought to be a juſt quantity of blood. If its velocity be increaſed, and if, at the ſame time, there be too great a proportion of it, then is it probable that the *impetus* on the glands, being greater than it ought, will prove the cauſe of crude ſecretions; and that this may be the caſe with the brain, as well as with the other glands, we have no reaſon to doubt.

Nor is it likely that the perſpirable matter retained ſhould furniſh freſh ſupplies of animal ſpirits: and this agrees well with what Doctor Freind obſerves in another place, *viz.* that, about the time of menſtruation, women are affected with a *languor*, from the too great weight of the body, and from the dilatation of the finer blood veſſels of the brain, whereby the paſſage of the nervous fluid into the nerves is obſtructed, and hence the members of the body are

deprived of their due quantity of animal ſpirits *.

But, however plauſible this reaſoning may appear, it is to be preſumed, that, in a PLETHORA, *cæteris paribus*, the velocity of the blood will not be increaſed, but, on the contrary, will be diminiſhed.

To preſerve the animal œconomy, a certain *ratio* betwixt the quantity of blood, and the elaſtic power of the heart and arteries, is neceſſary: ſo that an additional quantity of blood is not always to be ſuppoſed neceſſary to conſtitute a PLETHORA; for this ſtate may ariſe as well from the diminiſhed force of the heart, the quantity of blood remaining unchanged, as from an increaſed quantity of blood with the ſame force of the heart. Thus, in conſumptions, the ſolids

* Languor vero invadit, quia in plethora nimio pondere laborat corpus, et tenera cerebri vaſcula ita turgeſcunt, ut compreſſu ſuo, omnes pene in nervos aditus præcludunt, hinc in membra minor derivatur ſpirituum copia. Emmenol. cap. 8.

lids waſting, and the heart becoming weaker, occaſion a PLETHORA, the proportion of blood being too great for the force of the heart; ſo that bleeding, by reſtoring the balance, gives a temporary relief to the patient; and the power of the heart ſtill diminiſhing, the ſame evacuation becomes again neceſſary. But in this eſſay, a PLETHORA is to be underſtood as proceeding from an increaſe of blood.

THE natural ſtate of an artery is ſuppoſed to be its ſyſtole: any degree of extenſion beyond this ſtate is owing to force. When there is a redundance of blood, it is to be believed that the arteries cannot return entirely to their natural ſtate, but muſt ſuffer ſome degree of extenſion even in the ſyſtole. This, as I ſaid, we muſt call a PLETHORA, in the ſtricteſt ſenſe, and ſeems to be the ſimpleſt idea we can form of a PLETHORA ariſing from a redundance of blood. For, could the arteries act with a full vibration, and return from their diaſtole to their natu-

ral ſtate with entire freedom, it could not be ſaid that there was more blood in the body than juſt enough.

It hath been found that a ſmall difference in the dilatation of an artery requires a great number of pulſations to compenſate it. And as, in a PLETHORA, the vibrations of the arteries muſt be more confined than uſual, a proportional acceleration of the pulſe becomes neceſſary to preſerve an equal degree of velocity in the blood; but, to increaſe the velocity of the blood to any conſiderable degree, the pulſe muſt be greatly accelerated.

Thus, it is evident that the heart and arteries act with great diſadvantage in keeping up a due degree of velocity in a redundance of blood; and if there be any additional ſtimulus, whether from an increaſe of animal ſpirits, or otherwiſe, the effect will not ſhew itſelf in the contraction of the arteries, (fluids being of too incompreſſible a nature

nature to admit of that,) as in the acceleration of the pulſe.

It appears further from common obſervation, that, when there is a general PLETHORA near the time of menſtruation, (which is the caſe with ſome women about that period,) the circulation is ſlower than uſual. For, beſides that there is then either no acceleration of the pulſe at all, or an inconſiderable one with women otherwiſe in health, the vibrations of the arteries are generally obſerved to be more confined than when there is no PLETHORA. And it hath been found that the arteries are relieved, and recover their elaſticity, by bleeding in a PLETHORA. We ſhall ſee afterwards that this is wiſely ordered, ſince the eruption of the menſes is ſafely brought on by an increaſed quantity of blood, and a diminiſhed velocity, and that this diſcharge could not have happened without danger had there been an increaſe of both.

III. Thus

III. THUS far with reſpect to the effects of a general PLETHORA upon the circulation. But when we come to conſider the ſtructure, number, and diſpoſition of blood-veſſels belonging to the UTERUS, and neighbouring parts, it will appear that every thing is contrived, not only to prevent the rapid motion of the blood, but to make the circulation in theſe parts remarkably ſlow, even with a common quantity of blood, but much more ſo in a PLETHORA.

THAT this may appear the better, we are to conſider that the capacities of any number of branches coming off one trunk, when taken together, being greater than the capacity of that trunk, the motion of the blood in theſe branches will be proportionally ſlower than that in the trunk. Thus, if ſix branches come off one trunk, and if the diameter of each branch be two thirds of that of the trunk, then will the velocity in the branches be to that in the trunk as three to eight, the capacities being as the

ſquares

ſquares of the diameters, and the velocity reciprocally as the capacities.

THE blood ſent to the UTERUS, OVARIA, and VAGINA, is conveyed in the hypogaſtric, and ſpermatic arteries, of which two veſſels the ramifications are very remarkable for number and ſize: for not only a great many large branches are ſpread every where upon the UTERUS *, and VAGINA; but the LIGAMENTA ROTUNDA are little more than a *congeries* of blood veſſels.

WE cannot pretend to form a conjecture about the ſize and number of theſe branches, in proportion to the trunks from which they are derived; and, conſequently, what the preciſe *ratio* of the velocity in the branches to that in the trunks may be: but it is evident, in general, that the motion of the blood in theſe parts muſt be very ſlow †.

HAD

* Uterus arteriarum et venarum tela eſt et complicatio. Haller prælect.

† Doctor Keil found by an accurate menſuration, and computation, that the velocity in the thirtieth branching from any trunk is to the velocity of the blood in the trunk as unit is to 615.

Had an extraordinary velocity of the blood been neceſſary to produce the monthly eruption, the blood would have been conveyed to theſe parts by many trunks; and theſe trunks would have been large in proportion to their branches.

But when we find the circumſtances quite different, that is, few and very moderate trunks, with large and numerous ramifications, we muſt conclude that nature hath intended that there ſhould be a very languid circulation in theſe branches.

Beſides the ſlow circulation, the accumulation of the blood in the uterine veſſels, in a PLETHORA, is readily accounted for by attending to the three following circumſtances.

1. In animal bodies, the coats of the arteries are, in general, found to be thinner, and weaker the more theſe veſſels are ramified,

ſied, and the further they are removed from the original trunk.

2. THE larger the diameter of any artery is, or the greater its capacity in proportion to the thickneſs and ſtrength of its coats, or to its elaſticity, the leſs will the power of that artery be in carrying on the circulation.

3. THE more ſuſceptible any artery is of a great and ſudden diſtenſion from a minute and contracted ſtate, the weaker muſt that artery be.

BY comparing the numberleſs ramifications, and remarkable ſize of the uterine veſſels with what hath been ſaid above about a PLETHORA, it appears that the elaſtic power of theſe veſſels muſt ſoon yield to any additional force; and, conſequently, that, in a PLETHORA, there muſt be an uncommon determination of blood to theſe parts, and a collection of it there. To this likewiſe

the ſerpentine diſpoſition of the veſſels contributes not a little.

THE arteries of the UTERUS, before puberty, or ſoon after menſtruation, are ſo ſmall as to be inviſible, and do not admit red blood: but about the time of the eruption they are greatly diſtended *. This expanſion being ſo ſudden, the elaſtic power of theſe arteries muſt be very inconſiderable, when compared with that of the other arteries of the body of the ſame ſize, whoſe growth hath been ſlow, and in proportion with that of the body.

BUT it may be further obſerved, that the ſpermatic vein, being large in proportion to

* De Graaf tells us, that, in a woman whom he diſſected, near the time of menſtruation, he found the uterine veſſels enlarged to ſuch a degree as to admit his finger. The elaſtic power of the arteries in ſuch a ſtate muſt be almoſt entirely overcome.

Maxima arteria uteri non diſtenti, inviſibilis eſt, ſi cum arteria rubra comparatur: et hæc tamen inviſiblis arteria, adeo magna fit in utero pregnante, ut initium calami ſcriptorii admittat. Haller. prælect.

to the artery, and having no valves, muſt reſiſt the action of the arteries; ſince the column of blood in the vein is large, is to be raiſed almoſt perpendicularly, and is not ſupported by valves.

THESE obſervations would ſeem abundantly to ſhew how every thing is contrived to collect a great proportion of blood in the uterine arteries in a PLETHORA; and, by comparing all circumſtances, it is evident that, as the time of the menſtrual diſcharge approacheth, the circulation muſt be extremely ſlow in the larger veſſels of the UTERUS; and, if ſo, its motion in the finer branches, whoſe orifices open into the UTERUS and VAGINA, muſt be inconceivably languid: or, which is not improbable, there muſt be an abſolute ſtagnation in theſe ramifications for ſome little time before menſtruation.

THE effects then of a very ſlow circulation, or of a ſtagnation of the blood in

any part of the body, comes next to be conſidered.

IV. To preſerve the texture and ſoundneſs of the blood, a due degree of velocity, according to the ſize of the veſſels, is requiſite. When this fails, and the motion of the blood becomes much ſlower than it ought, it is obſerved to change its nature.

It hath been found that blood out of the body, and kept in the degree of animal heat, doth not coagulate, but ſoon tends to a putrid and diſolved ſtate *.

The *halitus*, too, which flies off when blood is expoſed to the air, being the moſt putreſcent part of it, muſt promote this tendency to putrefaction more while in the body than when out of it.

From this we may judge what change the blood undergoes in the body, when the circulation

* Theſes de ſanguinis ſeparatione ſpontanea, Auct. Martin. Butt.

circulation fails, or becomes ſo ſlow as to be next to ſtagnation: for the blood being pent up in the uterine veſſels, and the circulation being ſloweſt, or probably ceaſing in the laſt ramifications of the arteries, that is, in theſe which open into the cavity of the UTERUS and VAGINA, this blood, I ſay, in them, muſt tend to a diſſolution; and, by putrefying, muſt contract an acrimony ſufficient for irritating the containing veſſels, while the impulſe from behind ſtill increaſeth.

THESE two cauſes, co-operating, muſt at length produce an oozing from the uterine arteries into the cavity of the UTERUS and VAGINA; and this effect muſt continue ſo long as the cauſe; that is, till the PLETHORA ceaſe; the uterine veſſels collapſe or recover their tone; and till a due degree of velocity be reſtored to the fluids paſſing through theſe organs.

It may not be improper to obſerve here the analogy between the menſtrual and hemorrhoidal flux, eſpecially in thoſe with whom the latter is periodical. As the veſſels in the RECTUM gradually ſwell, the blood circulates ſlower in that part, and at length ſtagnating there, an acrimonious *ichor* then tranſudes, and, with ſome, blood breaks out, and continues to ooze till the veſſels be ſufficiently emptied.

Others, whoſe blood is of a looſer and weaker conſiſtence, and its quality acrimonious and ſcorbutic, have large and obſtinate hemorrhages this way; and women of the ſame conſtitution are no leſs ſubject to immoderate floodings from the UTERUS.

In this manner is the menſtrual flux carried on gently and ſafely: whereas, had a PLETHORA, and an increaſed velocity of circulation combined to make an eruption of arterial blood, it could not have happened without a ſudden and dangerous hemorrhage;

morrhage; as is known to be the caſe when the blood finds vent through the arteries where the circulation is rapid.

AFTER impregnation, the blood, going to form the fœtus and ſecundines, circulates through both in the ſame manner as through the mother; and, having its due degree of motion, undergoes no change in its quality.

UTERINE hemorrhages, after impregnation, are juſtly reputed dangerous: and yet it is well known that many women continue to menſtruate two or three times, or oftener, after impregnation. Whether the veſſels communicating with both the UTERUS and VAGINA, and paſſing from the one to the other, are intended to relieve the UTERUS, by throwing off part of the blood through the ſides of the VAGINA, when there is more than is neceſſary for the nouriſhment of the embrio, I leave to others to determine.

THE

THE *nauſea*, to which moſt women are ſubject during the firſt weeks of impregnation, ſeems alſo to be a wiſe intention of nature. For, as they are able to take but little food, while in this condition, leſs blood is proportionally generated, the derivation of blood to the UTERUS muſt likewiſe be leſs, and, conſequently, there muſt be leſs danger of hemorrhages from the uterine veſſels, and of abortion from that cauſe.

IT may be objected, that the menſtrual flux, according to Hippocrates *, Doctor Freind †, and others, conſiſts of the fineſt and pureſt arterial blood.

BUT this doth not follow becauſe it comes immediately from the arteries. Blood, if deprived of motion, and of a proper degree of conquaſſation, will contract a putrid and acrimonious

* Morb. Mulier. lib. 1. ſect. 15.

† Sanguis ille qui ejicitur—ex capillaribus arteriis erumpit; ideoque naturam arterioſi, h. e. puriſſimi ſanguinis retinet. Emmenol. cap. 2.

acrimonious quality in the arteries, as well as in the veins: and, though it become ſomewhat more liquid than in a natural ſtate, and contract a degree of acrimony, ſo as to irritate the containing arteries; yet ſtill it may retain the florid appearance of pure blood. Nor can we conclude from the browniſh, or duſkiſh colour of the menſtrual blood, that therefore it comes from the veins, as Aſtruc obſerves; ſince blood, becoming putrid from ſtagnation, or otherwiſe, contracts that colour *.

WERE the menſtrual blood pure, and abſolutely ſound, then might it be expected that ſudden obſtructions of the menſes, eſpecially from external cauſes, as putting the legs into cold water, ought not to be productive of ſuch troubleſome conſequences as commonly follow. Theſe effects are known to be, for the moſt part, obſtinate and untractable, continuing for many

* See Sir John Pringle's experiments on the blood.

months, ſometimes for years, and are frequently attended with ſymptoms indicating the maſs of blood to be tainted.

But if the menſtrual blood hath contracted a degree of putridity, and the ſame acrimonious quality that is found to be the conſequence of ſtagnation; then may this blood, in caſe of uterine obſtructions, be ſuppoſed ſoon to affect the maſs, and to produce the various evils which follow theſe obſtructions. A ſmall quantity of blood, tending to a putrid ſtate, being taken up, and circulating with the fluids, inſtead of paſſing off by the natural chanels, may well be ſuppoſed to ſpread its noxious quality through the animal frame, or to fall upon ſome particular member.

In this way the effects of theſe obſtructions ſeem to be more naturally accounted for, than by ſuppoſing a few ounces extraordinary of ſound blood to circulate through the body. A PLETHORA of this kind, we may

may reaſonably believe, ought to be corrected by bleeding. This evacuation, however, hath, for the moſt part, but little effect in removing diſorders ariſing from obſtructions of the menſes.

We are told, by ſeveral authors, of ſound blood being extracted from the UTERUS, after having been long confined there, by membranes obſtructing the paſſage, or by ſome unnatural formation of the parts.

But, though this blood might ſtill retain its fluidity, it doth not therefore follow that it was ſound, and free from acrimony. On the contrary, there are, generally, circumſtances mentioned, which prove blood thus retained to have contracted a greater, or leſs, degree of putridity.

Anthony Benevoli * extracted, from the UTERUS of a young woman, ſeveral pounds of blood which had been accumu-

* Diſſertazioni et obſervazioni, p. 79, &c.

lating there upwards of three years; and obſerves that it was ſtill ſo liquid as to paſs through the catheter, but had contracted a duſkiſh colour, and had the appearance of lees of wine.

RUYCH tells us, that, having extracted four pounds of blood from the UTERUS of a woman of twenty years of age, by piercing a membrane which totally obſtructed the paſſage, he was ſurpriſed to find the blood neither coagulated, nor fetid; but obſerves that it was of a blackiſh hue *.

ANOTHER caſe is told † of a great quantity of blood diſcharged from the UTERUS of a young woman, by the inciſion of a ſimilar membrane, where the blood is ſaid to have been of a good colour, very fluid, and no ways fetid. But, being expoſed to the air, it ſoon began to ferment, and flowed

* Obſervation. anatom. chirurg. cent. obſ. 32.

† Holl. Maatſchap. te Harlem. tom. 5. p. 424. & ſeq.

ed over the veſſel, though its edge was three inches above the ſurface of the blood, when firſt put into it. This was a certain proof of a very high degree of acrimony, notwithſtanding the appearance of ſound blood when firſt diſcharged *.

THUS it appears, from different examples, that blood may remain long in the UTERUS without coagulating, though it loſe the quality of ſound blood; and in ſo far theſe, and ſimilar caſes, ſtrengthen this theory of menſtruation, as likewiſe by ſhewing that the blood may be very acrimonious, and yet have the appearance of ſound blood; and further, that this blood, notwithſtanding its putrid and acrimonious quality, may remain in the UTERUS a long time, without hurt to that organ. But this laſt circumſtance might be

* Sanguis, inciſa membrana hac, erumpens, boni coloris erat, admodum fluidus, et nullum ſpirabat fœtorem: dum in vaſe receptus reponeretur, incepit rareſcere et fermentari, ita ut tranſcenderet margines vaſis, quamvis illi tribus digitis tranſverſis, eminerent ſupra contentum in vaſe ſanguinem. V. Commentar. B. Van Swieten in aphor. Boerhaave 1290.

be proved from many examples, which ſhew the blood to have been putrid upon its firſt eruption *.

It was perhaps from ſome examples of this kind that the ancients had contracted the opinion of the baneful quality of menſtrual blood. But, with women in health, according to this theory, an high degree of acrimony is not ſuppoſed: ſo much as to ſtimulate the veſſels gently, and promote the fluidity of the blood, can hardly fail to bring on the diſcharge with greater advantage, than merely a plenitude of the veſſels.

Nor is this ſtate of the uterus to be deemed morbid, notwithſtanding this acrimonious quality of the blood. For this change in the blood, being the neceſſary conſequence of a defect of motion and agitation, it becomes an excrementitious fluid, and

* Hildan. centur. 3. obſerv. 60. exempl. 2. Saviard. obſerv. 4.—For ſome other examples ſee Smellies Midwifery, vol. 2. collect. 2.

and would infect the maſs, were it again to be taken up, and to circulate with it, as the *ſaliva*, or urine, would affect the ſoundneſs of the blood, were they to be mixed with it, after having ceaſed to flow through the body with the general maſs.

If it be objected, that an acrimonious and reſolved ſtate of the menſtrual blood would endanger too ſudden, or too great an eruption; it may be obſerved, that, even with women who have the menſes ſo diluted as to appear pale, and like water tinged with blood, the diſcharge is frequently as gradual, as when the blood is of a better conſiſtence.

Thus far the theory of menſtruation ſeems to be a natural deduction of cauſes and effects. But there are ſome circumſtances relating to the menſes, the cauſes of which cannot be ſo eaſily traced; and particularly, why this evacuation doth not happen before the age of puberty.

The

THE reaſon why the menſes do not flow till this period, is commonly ſaid to be, becauſe the blood is expended in the increment of the body.

IT hath been obſerved, that, in the earlier periods of life, the ſolids, being ſoft and pliable, make leſs reſiſtance to the momentum of the blood, and therefore admit of expanſion and increment; but as the ſolids acquire a greater degree of firmneſs, they make greater reſiſtance to the action of the heart, and force of the blood. And as women approach their full growth, more blood being ſtill prepared than can be expended in any further increment, this exceſs muſt be diſpoſed of in ſome other way; and the UTERUS, it is ſaid, is a fit receptacle and emunctory for it *.

THE

* We may judge of the harmony of nature, in the œconomy of female bodies, by comparing the quantity of the menſtrual flux with the increment of the body, ſtill making allowance for the uncertainty of a computation of this kind. Let a woman of fifteen years of age weigh 130 pounds, the mean increment of each month in fifteen years is 8.66 ounces.

THE reaſon why the body ceaſeth to increaſe, after a certain period of life, hath been believed to be the firmneſs of the parts, and the reſiſtance thereby made to the motion of the fluids.

BUT the true cauſe is different from this; nor doth it depend upon the firmneſs of the parts, that the body ceaſeth to grow, but upon its ſize and weight in proportion to the force of the moving power. For, though the body were actually ſofter, and the parts more pliable at the age of puberty, or thereby, than when in a ſtate of childhood, it would not increaſe, or but very inconſiderably, from that cauſe.

IT may be obſerved that the univerſal law, with reſpect to the power and magnitude of machines, obtains likewiſe in animal bodies. Now, as the power of the firſt mover, in an animal body, increaſeth in a lower *ratio* than the incumberance and reſiſtance ariſing from the bulk and weight of

the machine, independent of the ſoftneſs, or hardneſs of its parts; therefore, ſo long as the moving power can do more than merely ſupport the body, or keep up the motion of the fluids, ſo long will the body continue to increaſe. But when the weight or magnitude of the body comes to be a juſt balance on the heart, it will do no more than preſerve the machine, by keeping up the circulation, without any further increment.

But though, about the age of puberty, the greater firmneſs of the parts ſhould occaſion a reaction from the more ſuperficial parts of the body upon the internal organs, it doth not appear that this would be ſufficient to produce the menſes at that period. The firmneſs which the ſolids acquire, as the body encreaſeth, is gradual; and the effect of the reaction of the fluids upon the uterine veſſels ought likewiſe to be ſo: whereas the accumulation of blood in theſe veſſels is ſudden; the UTERUS being of a firm conſiſtence, its veſſels appearing to be totally

void

void of blood not many days before, and after menſtruation, as hath been obſerved in the bodies of women who have been cut off by ſudden or violent deaths. Beſides, the body frequently continueth to grow remarkably after the firſt menſtrual eruption, nor doth it appear that the menſes are interrupted by this increment.

THOUGH therefore the above mentioned cauſe may co-operate, in ſome degree, with others, it is probable that there muſt likewiſe be a natural aptneſs, or diſpoſition in the UTERUS to receive the menſtrual blood, with which diſpoſition it had not been endued before this time, like many other changes which happen to the human body at particular periods of life, of which none are more remarkable than thoſe which both ſexes undergo about the time of puberty, the cauſes of which we are frequently unable to diſcover.

WHETHER the lymphatic fluid in the milky veſſels of the UTERUS, by acquiring a thicker conſiſtence about the time of puberty, and ſo compreſſing the uterine veins, may thus force the blood through the APPENDICES VENOSAE, according to Aſtruc's hypotheſis *, I ſhall not pretend to determine. But it doth not appear that the moſt expert anatomiſts have diſcovered ſufficient foundation for this theory.

IT remains now to enquire whether a general PLETHORA be neceſſary, or a partial one ſufficient to produce the menſes.

HAD all the arteries of the body been endued with an equal degree of elaſtic power, according to their capacities, in this caſe there could not have been any cauſe for a partial PLETHORA; for all the arteries acting with equal force, according to their diameters, muſt be ſuppoſed to have made an equal diſtribution of the blood: nor could there

* Maladie des femmes.

there have been any reaſon why a greater collection ſhould be in one part of the body than in another.

But if the arteries in any particular part of the body be ſo conſtructed as to admit of a quicker, and greater degree of dilatation than the reſt, in proportion to their elaſtic power, the blood muſt be collected in theſe veſſels, and muſt produce a PLETHORA in them, though there be none in any other part of the body, the reſt of the arteries propelling the blood with their uſual energy.

If we compare the aorta, and iliac arteries with thoſe of the UTERUS, which admit of a ſudden, and great dilatation, it will appear that the blood, being impelled by the ſtrong vibrations of the former arteries into the latter, muſt be collected there; for the uterine arteries, not being poſſeſſed of an equal degree of elaſtic power, according to their capacities, cannot propel the blood ſo quickly

quickly as it is conveyed to them. By this mechaniſm, joined with the diſpoſition to imbibe blood from the neighbouring arteries, with which the UTERUS is ſuppoſed to be endued at particular times, there muſt be ſuch a derivation of blood to theſe parts, as, with the change in its quality, ſhall at length be ſufficient to overcome the reſiſtance of the veſſels.

THAT a partial PLETHORA may take its riſe from a natural cauſe, and may ſubſiſt without a general PLETHORA, appears ſufficiently from the ſtate of the UTERUS after impregnation; the blood veſſels, during that period, particularly in the laſt months, being diſtended greatly beyond their uſual dimenſions *. Nor do pregnant women, if

* Quamvis autem uterus in junioribus puellis, et in adultis virginibus, ad tactum firmus et ſolidus deprehendatur; tamen graviditas docet hæc vaſa facile cedere poſſe, et in magnam amplitudinem dilatari, cum ultimo graviditatis tempore, uterus inſtar ſpongiæ ſanguine planæ appareat, cum vaſa ante vix conſpicua in utero non gravido, jam digiti minoris apicem quandoque capiant. Van Swieten.

if in health, diſcover any ſymptoms of a general PLETHORA, though the womb be then in a plethoric ſtate: on the contrary, many women, who enjoy perfect health during that period, look leaner, and leſs plethoric than before impregnation.

IT is to be obſerved, that, in inveſtigations of this kind, we ought not to take obſervations from women who are in any degree pained about the time of menſtruation. There are many women, particularly of the middle rank of life, who live in the country, and who, from the benefit of freſh air, ſufficient exerciſe, ſimple diet, and tranquillity of mind, feel no inconvenience, nor have any ſymptoms of a general PLETHORA about the time of the menſes.

BUT, though we daily meet with others who have evident ſymptoms of a general fulneſs, and a variety of troubleſome feelings about that period, we ought not therefore to conclude that theſe ſymptoms are more

more neceſſary than the many inconveniences which are frequently found to attend the other evacuations. It is from thoſe only who enjoy perfect health that we can judge with propriety of the œconomy of nature in animal bodies.

It may be objected that the uterine veſſels, when they ſuffer ſo great an expanſion from the impulſe of the menſtrual blood, muſt, by their reaction, produce a general PLETHORA in ſome degree.

Something of this nature might be ſuppoſed to happen did the conveyance of blood into the uterine veſſels depend ſolely on the action of the neighbouring arteries: but the UTERUS, according to this theory, being, by its particular conſtitution, and at certain periods, diſpoſed to imbibe blood, the impelling force of the neighbouring arteries becomes leſs neceſſary, nor can any degree of a general PLETHORA ariſe from the reaction

reaction of the uterine veſſels, when thus diſpoſed to attract the menſtrual blood.

It doth not appear that any ſatisfactory account of the conveyance of the menſtrual blood to theſe parts can be given, without having recourſe to an abſorbing quality in the uterine veſſels. For, if the determination of blood to the UTERUS depended wholly upon the action of the neighbouring arteries, then ought the menſtrual flux to increaſe, or diminiſh, as the action of theſe arteries, and the momentum of the blood become greater or leſs; which doth not agree with common obſervation: for neither the times, nor quantities of the menſes are affected by exerciſe and reſt, or by the ſtronger, or weaker action of the heart, ſo much as they ought, if the periodical collection of blood in theſe parts depended wholly on its momentum being increaſed by the addition of a few ounces.

THERE ſeems to be ſome analogy between the ſeeds of plants and the UTERUS of animals. Seeds have a remarkable attracting, and abſorbing quality, ſo that, when they are expoſed to warmth and moiſture, more or leſs, according to the nature of the ſeeds, they ſoon imbibe, ſwell, and germinate: and, though the external preſſure of the ambient moiſture may have its effect in forwarding this change in the ſeed, yet doth its internal motion ariſe chiefly from its attracting, or abſorbing virtue, depending upon its original organization. The efficient cauſe of this is unknown to us. On this natural diſpoſition of the ſeed the nouriſhment and growth of the future plant, in a great meaſure, depends; and ſeeds which have reached maturity imbibe more readily, and more plentifully, than others which have never come to a full ripeneſs: accordingly, the latter produce either weakly plants, or none at all.

In like manner may the UTERUS, at a particular period of life, or when come to a certain degree of maturity, acquire a power of abſorbing the menſtrual blood, allowing ſtill the adjacent arteries to have their ſhare in forwarding this accumulation of blood; for which, however, the action of theſe arteries ſeems to be of itſelf inſufficient, without the abſorbing power of the uterine veſſels.

But, though a partial or local PLETHORA be here allowed, it can only be underſtood to be ſo on certain conditions. A PLETHORA is commonly ſuppoſed to include ſomething morbid. But, in the preſent caſe, it can have no meaning of this kind, ſince the uterine veſſels, in collecting, and voiding the menſtrual blood, diſcharge their natural functions, as much as the liver in ſecreting bile, or the urinary bladder in collecting, and diſcharging the urine.

But, if by a partial PLETHORA be meant ſuch a quantity of blood collected in

any particular organ, as cannot be propelled in the common courſe of circulation, whether this proceed from the peculiar dilatability of the veſſels, and their ſmall elaſtic power in proportion to their ſize, or from whatever other cauſe, then muſt the UTERUS be allowed to be in a plethoric ſtate about the time of menſtruation.

BY a general PLETHORA, as hath been obſerved above, is underſtood a greater quantity of blood than the moving power is able conveniently to circulate: but the blood cannot thus exceed the mean quantity without a morbid ſtate of the body. Now it would be prepoſterous to ſuppoſe a natural effect, or ſuch as is indiſpenſible in the animal œconomy, to depend neceſſarily upon a morbid, or unnatural cauſe *.

THIS

* It may be proper to obſerve, that, by a natural cauſe, or effect, nothing more is meant here than what is neceſſary or conducive to the preſervation of the animal œconomy, without regard to the general or abſtract ſenſe of cauſe and effect. Thus, poiſon, taken into the ſtomach, may deſtroy the animal frame by reducing the blood to a putrid ſtate. This, with reſpect to the animal

THIS is a difficulty in which thoſe muſt be involved who ſuppoſe a general PLETHORA neceſſary to produce the menſes. And with reſpect to a partial, or local PLETHORA, that name may be aſſigned to it, or not, according to the ſenſe affixed to the word.

IT hath been ſaid that the erect poſture of women is one cauſe, among others, of menſtruation: and that the horizontal poſture of brutes contributes to prevent it in them.

BUT, though the internal parts of generation in women be perpendicular, or nearly ſo, the veſſels belonging to theſe parts are moſtly

animal œconomy, is an unnatural, or morbid effect, produced by a cauſe of the ſame kind. But the reſolution of the blood is a natural effect of the poiſon, when conſidered in an abſtract ſenſe, and without regard to the animal œconomy. This obſervation is the more neceſſary, that the words *nature*, and *natural*, being variouſly applied, have ſometimes been miſunderſtood. Natural actions are mentioned ſometimes as contradiſtinguiſhed from vital, and animal actions; at other times in oppoſition to unnatural actions.

moſtly horizontal, or obliquely lateral; which direction is the moſt commodious for collecting the blood, and for preventing its too ſudden eruptions. And, though the perpendicular column of blood betwixt the heart and the UTERUS may have ſome effect in promoting the menſes, this can be but inconſiderable, when compared with the impelling force of the aorta, iliacs, and hypogaſtric arteries, and with the aptneſs of the uterine arteries to abſorb the menſtrual blood at theſe periods; hence it is common for women, confined to beds, to menſtruate as regularly as others in health, who uſe an erect poſture.

THE diſeaſes incident to the UTERUS are known to be numerous, nor is any other part of the body ſo immediately affected by the paſſions of the mind. 'Uterus nullum 'ſibi præter animi pathemata hoſtem novit,' ſays Van Helmont; and it is remarkable that the ſame paſſions are frequently productive of oppoſite effects. A violent emotion of the

the mind, from grief, or anxiety, from a ſudden fright, or from an immoderate fit of anger, ſometimes ſtops the menſes; and, at other times, proves the cauſe of an immoderate flux. It muſt be owned, however, that the mutual influences of the mind and body upon each other is ſo intimately connected that it is frequently difficult, if not impoſſible, to diſtinguiſh which is the cauſe, and which the effect. But it is certain that extravagant emotions of the mind are often the immediate cauſe of irregularities in menſtruation.

Women, who live in indolence, and delicacy, having for the moſt part weak ſyſtems of nerves, the common effect of too little exerciſe, the mind thereby contracts an imbecillity, which diſcovers itſelf by a too great quickneſs, and ſenſibility of the paſſions; a ſtate of the mind rarely to be found among women who lead active lives, or who are much accuſtomed to labour. From too great an irritability of the nerves, from a defective perſpiration,

perſpiration, and other effects of indolence, follow irregularities in the digeſtions, ſecretions, and, in general, in the circulation. Accordingly, women who are naturally indolent, or whoſe buſineſs reſtricts them to ſedentary lives, are obſerved to be ſubject to palpitations of the heart, ſoundings in the ears, indiſtinct viſion at times, giddineſs, tenſion about the hypochondria, yawnings, ſighings, quick breathing upon uſing motion, laſſitude, coldneſs ſometimes in one part of the body, and ſometimes in another, as in the ſcalp, nap of the neck, or ſpine of the back, and particularly in the feet and legs. Beſides theſe ſymptoms, flatulency and coſtiveneſs are evils attending this kind of life. Theſe ſymptoms, when met with in female conſtitutions, are commonly ranked among hyſterical diſorders, though they do not always proceed immediately from any fault in the UTERUS; they are, however, for the moſt part attended with irregular menſtruation.

WHATEVER

WHATEVER regimen invigorates the body, and contributes to animation, will be found to correct, or remove theſe diſorders, and to forward the operation of medicines. Hence the ſucceſs of attending mineral wells. For, though the waters may have their ſhare in rectifying enfeebled conſtitutions, there are many other circumſtances which prove no leſs ſalutary. On theſe occaſions, exerciſe, rarely neglected at the wells, new and agreeable company, change of air, a variety of ſcenes, in travelling to and from the Spaws, regularity in diet, and proper food, commonly attended to during the uſe of the waters, and abſence from buſineſs, or from whatever may be productive of care and anxiety in the mind; theſe circumſtances, I ſay, by amuſing and ſupporting the mind, and invigorating the body, cooperate to repair the conſtitution. Thus, as immoderate menſtruation, and likewiſe obſtructions, are frequently effects of the ſame cauſe, ſo are theſe effects, however

oppoſite, often corrected by the ſame method.

In obſtructions of a more obſtinate nature, the UTERUS ſeems entirely to loſe the faculty of abſorbing blood from the adjacent arteries, ſo that, in theſe caſes, the ſymptoms which uſed to precede the monthly flux are not at all felt. But though the uterine veſſels may, in ſome degree, retain or recover this abſorbing quality, it frequently happens that they are unable to diſcharge the menſtrual blood. This is known to be the ſtate of the UTERUS, when, at the expected period, but without any ſubſequent menſtrual diſcharge, there is a ſenſation of the ordinary ſymptoms which uſed to indicate the approach of the periodical flux. In this caſe it is to be preſumed that medicines of a warm and ſtimulating quality may be given with greater advantage, and ſafety, than in the former, in which the uterine veſſels, being in a collapſed ſtate, cannot be ſuppoſed to be affected by the virtues of medicines,

dicines, with the ſame advantage, as when theſe veſſels admit a proportion of the menſtrual blood. I had lately an opportunity of knowing the caſe of two women under uterine obſtructions, who, for ſeveral months, not having felt any ſymptoms indicating a derivation of blood to the UTERUS, were, by the uſe of an empiric medicine, given as a certain deobſtruent, thrown into conſiderable diſorders, as throbbings about the *præcordia*, a quick low pulſe, faintiſhneſs, and the like ſymptoms: others, with whom the menſes flowed very ſparingly, uſed the ſame medicine with advantage.

WHEN the menſtrual blood is received into the uterine veſſels, and is not diſcharged, but retained there ſome time, being again taken up in the courſe of circulation, and mixing with the other fluids of the body, it creates numberleſs diſorders in the conſtitution.

For the diſorders of the UTERUS there is hitherto no medicine known, which can be properly termed a ſpecific, or whoſe effects are equally certain in theſe diſorders, as the bark in intermitting fevers, or as mercury in exciting a ſalivation.

Aloes having been found effectual, in opening the hemorrhoidal veſſels, hath therefore been uſed as an emmenagogue. But it may be doubted whether it doth not, by this effect, divert the uterine flux, ſince, by increaſing one diſcharge, we generally find others to be diminiſhed. Nor is it improbable that the communication betwixt the uterine and hemorrhoidal veſſels may have been intended to relieve the UTERUS upon occaſions. When women reach that period of life, in which the menſes begin to ceaſe, they are often ſubject to a diſcharge of blood by ſtool, the hemorrhoidal veſſels, in ſo far, carrying on that flux, when the UTERUS becomes unfit for it; and there is reaſon to believe that, in the early periods of pregnancy,

nancy, miſcarriages have ſometimes been prevented by an hemorrhoidal flux, when not immoderate, the uterine veſſels being thus relieved, when a leſs proportion of blood was ſufficient for the nutrition of the embryo than was perhaps conveyed to the UTERUS and neighbouring parts. But, as purgatives are frequently neceſſary in uterine obſtructions, aloes may be preferable to many other cathartics, being of a warm and ſtimulating nature; and, as ſuch, hath been uſed ever ſince the days of Celſus *.

MERCURY, from its weight and diviſibility, proves, in many caſes, a powerful deobſtruent, and gives an *impetus* to the maſs of blood. But, from the ſoft and looſe texture of female bodies, it hath been found either to run off by ſtool, or to affect the glands of the mouth, before it overcome the uterine obſtructions. Opium, ſteel, caſtor, colocynth, and many other medicines are

* Sed medicamenta ſtomachum fere lædunt, ideoque omnibus catharticis aloe miſcenda eſt. Lib. 2. cap. 12.

are known to have virtues in hyſterical diſorders, when properly applied.

It hath been propoſed, by ſome, as a problem, why phlebotomy doth not anſwer the purpoſes of a diſcharge of blood by the UTERUS.

Had the cauſe of the menſes been a general PLETHORA, an equal quantity of blood taken from any other part of the body might have prevented the uterine flux; but, in this event, nature would have been defective with reſpect to the final cauſe; ſince every accidental hemorrhage, though from parts of the body remote from the UTERUS, would have endangered, if not deſtroyed the fœtus. There are many inſtances which tend to prove that phlebotomy hath little, if any influence, either in promoting, or in ſtopping the menſtrual flux.

When we conſider that the blood is conveyed to the UTERUS by large and elaſtic arteries,

arteries, and to this when we add the particular diſpoſition, or abſorbing quality, with which the uterine veſſels are ſuppoſed to be endued, it will appear that this organ muſt be ſupplied with blood, ſo long as the heart acts, and the UTERUS retains that faculty. Accordingly, many women menſtruate regularly, notwithſtanding profuſe hemorrhages from other parts of the body; and it hath often been found that tedious and waſting diſeaſes do not prevent the monthly flux.

AN antipathy to phlebotomy, or a natural timidity, may, with ſome women, affect the menſtrual flux. But this effect muſt be aſcribed to a paſſion of the mind, which, as hath been already obſerved, hath no ſmall influence on the UTERUS. Phlebotomy hath been often found neceſſary and ſucceſsful in correcting other diſorders, not only during menſtruation, but during the flux of the *lochia* *.

FURTHER,

* Van Swieten. comm. in aphor. Boerh. de pleurit. Tulp. obſerv. med. lib 2. cap. 2. La Motte traite des accouchem. liv. 2. cap. 21.

FURTHER, by obſerving final cauſes; which merit our attention, while we inveſtigate the operations of nature, there is reaſon to believe, from the œconomy of female bodies, that the preſervation and nutrition of the fœtus, from its firſt rudiments to its birth, are of ſo great importance as to render it neceſſary that the UTERUS ſhould be endued with a temperament peculiar to itſelf, ſo as to act, in ſome reſpects, independent of the other parts of the body: and that, though a plentiful ſource of blood be in conſtant readineſs in the neighbouring veſſels, yet that the action of theſe arteries is inſufficient to impel the menſtrual blood into the UTERUS, till it be prompted to admit that blood by a ſtimulus, or faculty within itſelf, and independent of any external *impetus*. So that all theſe neighbouring arteries are ſubſervient to the UTERUS, to ſupply it with blood; though inſufficient, by their own action, to extend its veſſels beyond their inviſible ſtate, till they be diſpoſed, by their natural and peculiar faculty,

faculty, to abſorb the menſtrual blood, or ſo much as ſhall be ſufficient for the nutrition and increment of the fœtus *.

It may be further obſerved in ſupport of this theory of an innate power of attracting blood, that the UTERUS is moſt plentifully ſupplied with blood, when the arteries are in a direction the leaſt favourable for conveying it: for in the laſt period of geſtation, when the UTERUS is ſo raiſed as to bear up the abdominal *viſcera*, many of theſe arteries, inſtead of their former depending ſituation, are now bent upwards; and yet their ramifications, ſpread over the UTERUS, are never more turgid with blood, than when they are in this direction. But the weight of the fœtus and ſecundines at birth, compared with that of the menſtrual flux of nine months, is likewiſe a proof of the ex-

* Van Helmont had an idea of the *uterus*, as endued with a faculty, or power of this kind, independent, in ſo far, of the other parts of the body. 'Cum ſit uterus, perigrini hoſpitis inſtar, a 'corpore non niſi alimentaliter dependens, prout viſcus ab arbore 'cui innaſcitur. Cæterum uterus quadra vivit propria,' &c.

traordinary quantity of blood conveyed to theſe parts during geſtation.

AFTER impregnation the fœtus ſeems to be ſupplied with nouriſhment preferable to any part of the mother's body. Women, labouring under waſting diſeaſes, particularly pulmonary conſumptions, are frequently delivered of children, whoſe full and healthy appearance bears no proportion to the emaciated ſtate of the mothers. This ſhews the circulation in the body of the fœtus to have been more natural, and regular, than that in the mother's, with whom the action of the heart is, ſometimes in theſe caſes, ſo weak, that the circulation is, with difficulty, kept up *. When we compare this with what

* This more natural circulation in the body of the fœtus, than in that of the mother, may be accounted for, in ſome meaſure, from the moving power in the child's body being greater than that of the mother's, in proportion to the ſize of the two bodies, according to the univerſal law, which obtains in mechanics: for, of ſimilar machines, the ſmaller do more, in proportion to their magnitudes, than the larger. In the preſent caſe, the fœtus can have no nourishment but the tainted blood of the mother; and yet

what hath been obſerved, with reſpect to menſtruation during theſe diſeaſes, we may judge of the abſorbing power of the uterine veſſels.

yet we frequently ſee children reach a certain age and ſize before theſe diſeaſes diſcover themſelves, though the children muſt have had the morbid *ſomes* in their original *ſtamina*. Something of the ſame nature may be obſerved in vegetables, and probably from a ſimilar cauſe. Many plants decay, after having come to a certain ſize, with an healthy appearance; and the blights and mildews in corns are believed to be owing to a vitiation in the ſeed, which is ſaid to be corrected by ſoaking the ſeed in nitrous and other *lixivia*. But, with reſpect to the fœtus, perhaps the blood, which is conveyed to it, may undergo ſuch a percolation, in paſſing from the uterine veſſels to thoſe of the *placenta*, as to render it purer than that circulating in the mother's body; and thus it may contribute to the more ſalutary ſtate of the child.

ESSAY III.

OF

MEASURING PROPORTIONAL QUANTITIES OF HEAT.

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IT is about a century and an half ſince philoſophers began to meaſure the degrees of heat by means of inſtruments conſtructed for that purpoſe, nor is it certain to whom we owe this diſcovery. Galileo, Sanctorius, Father Paul, and Drebbel have their reſpective advocates *. It is not improbable that theſe inſtruments might have been

* The Dutch authors, particularly M. Hennert, one of the latèſt writers on this ſubject, make Drebbel the inventor. L'honneur de cette Decouverte, ſays M. Hennert, appertient aux Hollandois.—Je ferai voir que Sanctorius n'eſt pas l'inventeur des thermometres. Drebbel is ſaid to have invented his thermometer at Prague, during the ſiege of that town by the king of Bohemia, or afterwards in England. The ſiege of Prague was in the year 1620. It is probable, from Sanctorius's aphoriſms, that he had uſed a thermometer during his experiments. The aphoriſms were

been contrived by different inventors about the same time, since that was a period in which experimental philosophy began to be a serious study.

The illustrious Sir Isaac Newton, observing lintseed oil to admit of considerable degrees of expansion by heat, constructed a thermometer with that liquor: and, supposing the freezing point to be the limit betwixt heat and cold, graduated the thermometer upwards, making 12 degrees the heat of the human body: so that the heat of boiling water was something more than 34 of these degrees *.

Sir

were first published at Venice in 1614; that is, six years sooner than M. Hennert says that Drebbel had invented his thermometer. It may be further observed, since Drebbel's and Sanctorius's thermometers were of the same construction, that Drebbel might have had the idea of his from that of Sanctorius.

* To make Sir Isaac Newton's thermometer coincide with Farenheit's, boiling water ought not to be quite so high as 34.—[illegible] =33.75, which is the degree of boiling water in Sir Isaac's scale, that of animal heat being 12. But Sir Isaac found that from the first boiling to the most violent ebullition, the thermometer moved from 33 to 34.5 degrees in his scale, which, in Farenheit's, is no less than 8 degrees.

Sir Isaac, ſuppoſing equal dilatations of the fluid to indicate equal quantities of heat, makes the heat of boiling water to be nearly equal to thrice the heat of the human body.

Were it certain that the freezing point is the loweſt boundary of heat, and likewiſe that equal quantities of heat produce equal degrees of rarifaction in the fluids, then would the menſuration of heat become an eaſy matter.

But it hath not yet been determined whether there be really ſuch a thing as frigorific particles eſſentially diſtinct from heat. What we denominate cold, for all that hath been ſaid on that ſubject, may ſtill be no more than a diminution, or defect of heat, to certain degrees, according to the feelings of different animals, or of the ſame animals at different times, and the various ſenſations of heat and cold may depend upon the particular organization of animal bodies; ſo

that a medium, yielding a ſenſation of warmth to animals living in the polar circles, might quickly chill us to death.

WERE we to ſuppoſe the firſt degree of heat to be ſix diviſions of Sir Iſaac's ſcale lower than he hath made it, which is the beginning of Farenheit's, then would the proportion of the heat of the human body be to that of boiling water, only as 3 to 7 nearly: and were the firſt point to be moved ſtill lower, which, for what we know, ought to be the caſe, the proportions would vary accordingly.

As we are ignorant, therefore, of the beginning of heat, and probably ſhall never be able to diſcover the boundary betwixt heat and cold, or whether there be ſuch a thing in nature as an abſolute privation of heat, it is in vain to attempt the menſuration of any certain quantity of abſolute heat.

But as we may have *data* ſufficient to diſcover the proportion which different quantities bear to one another, without being able to meaſure any one of theſe quantities; ſo may we be able to meaſure the proportional degrees of heat, though it be not in our power to meaſure any quantity of abſolute heat. Thus we may ſuppoſe ourſelves able to diſcover the proportional diſtances of two, or more planets, from the ſun, without being able to meaſure the real diſtance of any of them.

The great difficulty in this attempt is to diſcover the *ratio* betwixt the dilatations of the fluids and the proportional quantities of heat upon which theſe dilatations depend. For though it be probable that the rarifactions of different fluids bear different proportions to equal quantities of heat; yet is it uncertain whether there be any fluid which admits of additional rarifactions preciſely equal to additional quantities of heat.

THE heat of the human body in a morbid ſtate is found ſometimes to exceed its natural heat by 10 or 12 degrees *; that is, from 95 or 96, to about 10 or 12 degrees upwards. But we do not know whether the ſame additional quantity of heat applied to the thermometer, when the mercury ſtands very low, might not raiſe it twice or thrice as many degrees.

IT hath been demonſtrated that the denſity of all rays, iſſuing from one common center, is in the inverſe *ratio* of the ſquares of the diſtances from that center †: and, as heat is propagated in right lines, as is univerſally believed, its ſtrength, or intenſity will be in the ſame *ratio*.

FROM this well known propoſition, a method is pointed out for conſtructing thermometers

* Mr Burton, on his thermometers, makes the natural heat of the blood 97 degrees, and fever-heat 112.; which latter is higher than I have ever found it.

† Keil's phyſics, lecture 1.

mometers ſhewing proportional quantities of heat; an inſtrument greatly wanted among naturaliſts.

If a thermometer, to be graduated in this manner, be placed at a given diſtance from any equal central heat, ſuppoſe at ſix inches; when it will riſe no higher, if it be removed to the diſtance of twelve inches, the heat in the former ſtation will be to that in the latter as 4 to 1. If the thermometer be removed to a third equal diſtance, the heat at the firſt ſtation will be to that at the laſt as 9 to 1. That at the ſecond to that at the third as 9 to 4; and ſo on. The numbers I, II, III, IV, *&c.* *, being marked on the ſcale, to ſhew the height of the mercury, correſponding to the different diſtances of the artificial heat, marked 1, 2, 3, 4, *&c.* the intermediate ſpaces may be divided indefinitely into fractional parts.

The

* Plate II. fig. 1.

THE inſtrument being graduated, if experiments are to be made, or the heat of two or more bodies to be compared, if the body or medium A, raiſe the mercury to a height correſponding to the diſtance 1.53, and the body B, to that correſponding to the diſtance 2.63. then would the heat of the body A, be to the heat of B, as $\overline{2.63}^2$, to $\overline{1.53}^2$.

SOME have been of opinion that the force of heat is not propagated according to this law; becauſe heat in the focus of a ſpeculum, eſpecially thoſe of the larger kinds, is very intenſe; whereas, at a moderate diſtance from the focus, we feel little or no heat.

BUT the reaſon of this is evident; for the rays diverging very quickly, ſoon become as rare as before they were collected. Thus the rays reflected from the ſpeculum A B *, having paſſed the focus F, become as rare as the parallel rays which fell on the ſpeculum, when theſe diverging rays are at the ſame diſtance from the focus as the focus

* Plate II. fig. 2.

cus itſelf is from the ſpeculum. So that the diſtance betwixt the focus and D, C, or E, is too little for experiments of this kind.

It may be further obſerved, that, though the rays iſſuing from a center would affect a thermometer according to this law, yet, if we were to apply the thermometer to the ignited body, or to immerſe it in the flame from which the rays are emitted, this law would ceaſe, the heat of the ignited body being much beyond the higheſt proportion of heat in the rays. But the focus of a ſpeculum is to be conſidered, with reſpect to the intenſeneſs of heat, as an ignited body, from the great colliſion of the particles of heat at the decuſſation of the rays; ſo that the heat of the rays, at a very ſmall diſtance from the focus, are found to bear no proportion to the heat in the focus.

One difficulty, which attends this conſtruction of thermometers, is to find an equal central heat: for, if the heat were to vary

vary but in a ſmall degree, the proportions would be loſt. Did concave mirrours form pencils of rays of a ſufficient length for experiments of this kind, they would perhaps be leſs exceptionable than any other method: but they are open to the objections juſt mentioned. Ignited metals cool according to a certain *ratio*; but to make allowance for this *ratio*, if it be really known, or to take it into the computation, would render the operation difficult, if at all practicable. The flames of candles ſeem to yield the moſt invariable heat, provided it were ſtrong enough to procure a ſcale of any conſiderable extent. But, till a better method ſhall be diſcovered, candles may be uſed with advantage in the following manner.

In place of making experiments of this kind by heat emitted from any central body, ſeveral candles may be placed at equal diſtances from the thermometer, and the proportional degrees of heat diſcovered by moving

moving the candles towards the inſtrument. For this purpoſe let a frame be conſtructed in the following manner.

Two beams, or pieces of wood, A B, and C D *, each two inches thick, four inches broad, and four feet four inches long, are to be fixed or ſunk into one another at the middle, E, ſo as to form four equal branches, making ſo many right angles with one another at the middle. In each branch muſt be a ſlit wide enough to receive a ſquare wooden ſocket, *e*, in which muſt be a cylindrical hole ſufficient to receive a large candle. The ſlit in each branch muſt be ſo long that the centers of the ſliding ſockets may be moved from the diſtance of 24 inches to that of 2 inches from the central point E. On each branch are to be marked croſs lines, or diviſions, at the diſtance of two inches from each other, as in the figure, and that next the center being two inches from it, the diviſion next the extremity of each

* Plate III.

branch will be 24 inches from the ſame central point. Each of the ſliding ſockets muſt likewiſe be marked with a line parallel to thoſe on the branches, and paſſing through the center of the cylindrical hole; ſo that, as the ſliding ſockets are moved along the ſlits, this line, falling in with the lines on each ſide, will ſhew exactly the diſtance of the axis of each candle from the center of the frame.

It will be further proper that the diviſions on the branches be ſubdivided into tenths, twentieths, or as many fractional parts as may be convenient; that, in moving the candles towards the thermometer, allowance may be made for the thickneſs of the ball. Thus, if the diameter of the ball be ſix tenths of an inch, then, in place of moving the ſliding ſocket ſo far forward as to make its croſs line coincide with that of the great diviſion, it muſt be three tenths of an inch ſhort of that diviſion.

THE frame ought to be ſupported by four feet, one at the extremity of each branch; and, that the reflexion of heat from the table or floor, on which the frame ſtands, may not affect the mercury, theſe feet ought to be four inches high at leaſt.

THE frame being thus prepared, the four candles, fixed in the ſockets, are to be placed at the diviſions next to the extremities of the branches, and a thermometer to be hung, preciſely over the central point of the frame, ſo high that its ball may be in an horizontal plane with the flames of the candles. Having obſerved the preciſe height at which the mercury ſtands by the heat of the candles at the moſt diſtant ſtation, let the ſockets and candles be moved to the next ſtation, and ſo on through the twelve ſtations. But in this proceſs there are ſeveral precautions which ought to be carefully attended to.

1. The tube, or ſtem of the thermometer to be graduated, muſt be fitted to a plate having Farenheit's diviſions on one ſide*; the other ſide to be left open for the new ſcale: the ball of the thermometer muſt be open on all ſides, that the heat from the four candles may act upon it without interruption.

2. The obſerver muſt not touch the thermometer during the operation, leſt he give it a vibratory motion, and muſt hold an handkerchief over his mouth, while he obſerves the height of the mercury, that his breath may not communicate any additional heat to the air about the inſtrument; nor ought more than two perſons to be in the room during the operation.

3. The interval betwixt each obſervation muſt be of a ſufficient length, that the obſerver may be ſure that the mercury will riſe

* Plate II. fig. 1.

riſe no higher before he move the candles to the next ſtation.

4. The thermometer muſt be ſo hung that it may be let lower as the flames of the candles become lower: for the ball of the thermometer muſt be conſtantly in an horizontal plane with the flames of the candles.

5. The candles muſt be exactly cylindrical from top to bottom; they ought likewiſe to be thicker than ordinary candles, that their flames may yield the greater heat; and they muſt ſtand preciſely perpendicular, for which purpoſe the ſockets muſt be pretty deep. They ought to be made of the fineſt tallow; for though waxen candles yield a purer flame, their heat is not ſo great. They muſt be regularly ſnuffed during the operation.

6. This operation ought to be in a large room, and the *apparatus* muſt be in a part

part of the room where there is no current or circulation of air.

7. THERE ought to be one or more thermometers in the room, at ſome diſtance from the *apparatus*, to ſhew that the air of the room without the ſphere of the candles retains the ſame degree of heat from the beginning to the end of the proceſs; and when this is the caſe, then will the riſing of the thermometer be the effect of the heat of the candles only, and the various heights of the mercury will be in the proportion mentioned above.

FROM ſome experiments made to this purpoſe, it appears that four candles of an ordinary ſize make a ſenſible impreſſion on the mercury at the diſtance of two feet; and that the ſame candles, when brought to the diſtance of three inches from the ball of the thermometer, raiſe the mercury to 86°. in Farenheit's ſcale, when the thermometer, by the heat of the air, ſtands about 40°. ſo that, by

larger

larger candles, and theſe brought ſo near as two inches, it is to be believed that the mercury may be raiſed conſiderably above 100°. and if the ſtate of the air be ſuch that the thermometer ſtands about the freezing point, a ſcale of the extent of 70, 80, or perhaps 90°. of Farenheit's thermometer may be procured; and, conſequently, we may, by this method, be enabled to compare proportional degrees of heat, from the freezing point to the heat of the human body, and upwards.

But, if more heat be wanted, a frame may be conſtructed to receive ſix, or eight candles. It may be further obſerved, that the aſcent of the mercury, upon moving the candles from the moſt diſtant ſtation to the next, may be ſo ſmall, that it will be adviſeable to advance the candles four inches in place of two, for the two or three firſt obſervations, that is, from 24 to 20, and from 20 to 16, *&c.* inches from the ball of the thermometer.

It is not meant that thermometers, graduated after this manner, ſhould ſuperſede Farenheit's, and other thermometers now in uſe: theſe would ſtill be valuable, as well for their eaſy conſtruction, as for the great extent of their ſcales, and would ſerve all the common purpoſes of regulating heat. Nor is it pretended that this propoſal is, in every reſpect, ſecure againſt objection, or that the execution will be unattended with difficulties. It is, however, worthy of being brought to trial, being an attempt to find the ſolution of a problem which hath been given up as impoſſible: and if the conſtruction of thermometers after this manner be found to anſwer as well in practice as in theory, we ſhould be ſatisfied in many parts of natural hiſtory hitherto unknown, ſuch as the proportion betwixt the mean heat of ſummer and that of winter, betwixt the heat of the human body and that of the air at different ſeaſons, and many other curious problems which cannot otherwiſe be ſolved.

It may, at firſt ſight, appear an objection, that the ſcales will be different according to the different degrees of the heat of the air when obſervations of this kind are taken. Thus, in winter, or when the air is very cold, a longer ſcale would be procured, than in ſummer, when the mercury ſtands high, though we uſe the ſame artificial heat, and at the ſame diſtances.

This is indeed true. But the difficulty evaniſheth, when we conſider, that, though the one ſcale be more or leſs extenſive than the other, their diviſions will, nevertheleſs, be proportional. Thus, if the heat of the air be at one time as twenty, and at another as thirty; and the additional artificial heat, or its exceſs above the heat of the air, as five in one ſtation, and as ten in another, theſe two numbers, bearing an higher proportion to twenty than to thirty, will affect the thermometer more in the former ſtate of the air, than in the latter; and, conſequently, will make a larger ſcale, when the

air is cold, than when it is hot, though their diviſions will be proportional to one another, as the lines BC, DE, FG *, in the triangle A B C, and the parts of theſe lines, divided by A *n*, and A *m*, are all proportional to one another.

AGAIN, if BC be one ſcale, and FG another, then will the heat at *m*, bear the ſame proportion to that at *n*, as the heat at *o*, to that at *p*. If C be the height of the mercury in a cold ſtate of the air, and when the artificial heat is at the moſt diſtant ſtation, and G its height, when the artificial heat is at the ſame diſtance, but the air in a warmer ſtate; then will the difference be C *r*: but, when the artificial heat is brought ſo near as to raiſe the mercury in the one ſcale to *p*, and in the other to *n*; then will the difference be *n s*. In general, the leſs the difference is betwixt the artificial heat and that of the air, the ſcale and its proportional parts will be the ſmaller, as H I; and if

* Plate II. fig. 3.

if the heat of the air be ſuppoſed equal to the artificial heat, that is, the line A C, to meet the line A B, as at A; then, the difference being deſtroyed, no ſcale could be obtained; for to mix two fluids of an equal degree of heat, makes no increaſe of heat.

THUS, by taking different ſcales, when the air, with reſpect to heat and cold, is in the moſt oppoſite ſtates, we may be enabled to form a general ſcale, ſhewing the proportional degrees of heat, in any ſtate of the air. For example, when its heat is about twenty-five degrees, the ſcale *b d* * may be procured; and the ſcale *a c*, when its heat is about 77. Theſe two ſcales being delineated, or engraved parallel to, and at any proper diſtance from one another, as *a c* and *b d*; and lines being drawn from the numbers of the one ſcale to the correſpond-

* Plate IV.—It may be obſerved that the example of this general ſcale of proportional heats, in the plate, is not digeſted from experiments, or according to proportions founded in nature; but only to ſhew the form and uſe of ſuch a table.

ing numbers of the other, as from I to I, from II to II, from III to III, and ſo on, a table may be formed which will ſhew the proportional degrees of heat in any ſtate of the air betwixt theſe two ſcales.

Thus the lines *a b*, and *c d*, with the intermediate oblique lines, ſhew the form of ſuch a general ſcale: and, having diſcovered the *ratio* of the diſtances betwixt theſe lines, they may be produced to any length; for, as nature conſtantly acts by ſome law, it is to be preſumed that this law may be aſcertained by a ſufficient number of experiments.

THIS table ought to have Farenheit's ſcale on each ſide, as A C, and B D, with parallel horizontal lines paſſing from the numbers of one ſide to the ſame numbers of the other, at proper diſtances, as from 120 to 120, from 100 to 100, from 80 to 80, *&c.* Thus the height of the mercury in Farenheit's thermometer may be conveniently compared with the table of proportional

tional heats, the parallel lines of the one interſecting the oblique lines of the other.

THE uſe of this table will appear better from an example. If the heat of the human body is to be compared with that of any other body, or medium of ſeventy degrees in Farenheit's thermometer, the heat of the air being in ſome intermediate ſtate betwixt the two ſcales of proportional heats, as *e f*; then *m*, being at ninety ſix in Farenheit's ſcale, is the heat of the human body; and *n*, being at ſeventy in the ſame ſcale, is the heat of the other body. Therefore, *m*, falling on the ſcale *e f*, at IV, and four tenths *, that is, at the number ſhewing the diſtance of the artificial heat from the thermometer, and *n*, falling on the ſame ſcale at the diſtance of VIII, and ſix tenths, the heat at *m*, will be to that at *n*, as $\overline{8.6}^2$ to $\overline{4.4}^2$: that is, the heat of the human body will be

* It is ſufficient, in this example, to ſuppoſe the fractional parts, though none be marked on the ſcale.

be to that of the other body as 73.96. to 19.36.

In this manner may the heat of two or more bodies be compared. But, if the heats of the ſame two bodies are to be compared with the heat of the air when in different ſtates, it will be neceſſary to find the proportional numbers, ſhewing the heats of theſe bodies in the different ſcales, before comparing them with that of the air.

If, therefore, the heats of the ſame two bodies are to be compared when the air is in a cooler ſtate, as in the ſcale $g\,h$, then the numbers, expreſſing the proportional heats, will be different, but in the ſame *ratio* as the preceding numbers; for the heats ninety ſix and ſeventy, in Farenheit's ſcale, falling now at o, and p, will be in the following proportion; $n : m :: p : \frac{mp}{n} = o$; which is in numbers thus, 73.96 : 19.36 :: 39.69 : 10.39. which laſt 10.39, is the proportional heat

at

at *p*, the ſquare root of that number being the diſtance of the artificial heat from the thermometer, correſponding to *o*, in this ſcale; and bears the ſame proportion to 39.69, the heat at *o*, as 19.36, to 73.96.

In comparing the heat of any body with that of the air, it may be obſerved that, of the two numbers ſhewing the proportional heats, the one will vary as the ſcale is larger or ſmaller, the other will be conſtantly as the ſquare of the greateſt diſtance of the artificial heat from the thermometer, which will be nearly the natural heat of the air at the time of the experiment. Thus, when we compare the heat of the blood with that of the air, when the thermometer ſtands at ſixty degrees, as in the ſcale *e f*, the heat at *m*, will be to the heat at *f*, as 144 to 19.36. But in the ſcale *g h*, that is, when the thermometer ſtands at forty degrees, the heat of the blood will be to that of the air as 144 to 10.39. In the ſame manner, the heat

heat of the other body, or medium of seventy degrees, may be compared with that of the air.

Essay IV.

ESSAY IV.

OF

INSALUTARY CONSTITUTIONS of the AIR, from a Defect of WINDS of the higher Degrees.

ESSAY IV.

OF

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IN the regiſters of the weather, which have been kept with a view to aſcertain the remote cauſes of epidemical diſeaſes, the gravity, heat, and humidity of the air, have been regularly attended to; the quantities of rain, and the direction of winds, have likewiſe ſometimes been noted; but the degrees of winds have frequently been neglected. It is intended, in this ſhort eſſay, to ſhew the impropriety of this omiſſion, in theſe regiſters.

As the cauſe of winds hath been frequently a ſubject of enquiry among natu-

raliſts in general, ſo have their effects upon animal bodies more particularly attracted the attention of medical authors ever ſince the days of Hyppocrates.

When we endeavour to trace the cauſes of epidemical diſeaſes from journals of the weather, if in theſe journals the degrees of winds have been omitted, we are not only unable to draw any ſatisfactory conjecture from them, but are frequently led to believe, either that the ſtate of the air, or that of diſeaſes, ought to have been oppoſite to that which appears from the regiſters.

Thus, when we find, in a journal of the weather, that the barometer hath been very low for a conſiderable time, the humidity and heat being at a mean degree, we are apt to conclude this conſtitution of the air to have been unwholeſome; which is often the caſe, when a low barometer is attended with continued calms. But when this low ſtate of the mercury proceeds from high and

ſtormy

ſtormy winds, it, for the moſt part, indicates a ſalutary conſtitution of the air, and, in ſo far, the agitation of the air ſeems to compenſate its defect of gravity.

As to the directions of winds, independent of their force, theſe which move along the ſame climates, though with oppoſite directions at different times, have been found to acquire particular qualities, according to the nature of the tracts of land or water over which they paſs. But, in latitudes conſiderably diſtant from the equator, winds coming from oppoſite climates are obſerved to poſſeſs different, and, frequently, oppoſite qualities, beſides thoſe which they acquire from cauſes common to all winds. This is the caſe with north and ſouth winds in the higher latitudes.

The ancients univerſally aſcribe a baneful quality to ſouth winds; and the learned Hoffman, though living in a much more northern climate than the ancient medical authors,

authors, agrees with them in the effects of south winds. It must be owned, however, that south winds are not so much to be feared in these northern latitudes, nor have north winds always the same salutary effects with us, that Hyppocrates, Aristotle, Celsus, and Galen found them to have in the more southern climates. With us the good or bad effects of north winds seem to depend on the period of the year in which they blow: for, about the end of the spring, or the beginning of summer, when pinching north winds follow a warm state of the air, these winds are productive of rheums, coughs, and inflammations, affecting chiefly the pleura, and lungs. But, from the summer solstice to the autumnal equinox, or some time after it, northerly winds are observed to correct that state of the air which promotes putrefaction, the causes of which in the air are heat, humidity, and continued calms, or warm south winds. The air, when in this state, seems frequently to be impregnated with a sulphureous *gas*, which,

at

at times, manifeſts itſelf by meteors, coruſcations, thunders, and luminous appearances on ſwampy grounds.

NORTH winds, in general, check or retard vegetation with us. But, in thoſe parts of Aſia and Africa which lie next to the Mediterranean ſea, theſe winds are favourable to vegetation, as we are told by thoſe who have viſited theſe countries *.

HIGH winds are no where more neceſſary than in great cities, and chiefly after long calms; for the feculencies of different kinds, being collected, contract a more noxious quality than can be corrected by winds of the lower degrees.

BY a computation † of the quantities of winds of particular degrees, made from a regiſter

* For the effects of winds depending on their directions, ſee Lord Bacon's *hiſtoria ventorum*, and Hoffman's diſſertation *de phyſicis meditationibus circa ventorum cauſam, &c.*

† By this computation, it was intended to aſcertain the proportion of time which may be reckoned upon for the motion of the heavier

giſter of the weather, which had been kept for five years, it appeared that ſeven months, in two years of that period, were remarkable for a defect of winds of the higher degrees, and bore a ſmall proportion to winds of theſe degrees in the ſame months of the other three years.

THE months and years were from June to December, incluſive of the years 1732 and 1735. In which periods the mean proportion of the winds of the third degree and upwards, was to the whole time of theſe ſeven months, in each of theſe two years, as unit to 17.1. But in the ſame months of each of the other three years, the mean proportion of theſe winds was to the whole time of the months in each year, as unit to 8.2. This was a remarkable diſproportion.

GREAT

heavier kinds of wind machines, ſuch as are uſed for draining coal-pits by pumps. The regiſter was kept by Doctor Jurin's method, the winds being divided into four degrees. It was neceſſary for this computation, to find a mean betwixt the ſecond and third degrees.

GREAT ſtorms, as Doctor Huxham obſerves, frequently give a check to epidemic fevers. In the ſeven months of the two ſickly years, there were only four hurricanes, or winds of the fourth degree. But in the ſame months of the other three years there were thirty three; that is, the winds of this degree, in each of the former periods, were to thoſe in each of the latter, as 2 to 11.

THAT I might know the effects of this conſtitution of the air on the human body, I examined the hiſtory of diſeaſes during the latter part of theſe months, and the period following them; for, unleſs the air be noxious to an uncommon degree, its effects do not appear on the human body till ſometime after the cauſe; and the diſtance of time, it may be preſumed, will be greater or leſs, according as the diſpoſition of the body to admit, or its power to reſiſt the remote morbid cauſe, are greater.

To begin with the month of Auguſt 1732; the progreſs of the epidemics was according to the following ſhort account.

From the beginning of Auguſt to the end of October, a fever of the low kind prevailed, chiefly among the inferior rank of people, and ſoon became mortal. The fever was attended with ſevere headachs, ravings, and ſometimes with a diarrhœa; in the two latter months, the diſeaſe became more fatal, the patients dying about the eighth or ninth day, having been attacked early with a ſtupor, and lethargic liſtleſneſs. Many of the diſeaſed voided worms of different kinds: which, in fevers, generally proceed from bilious or acrimonious humours lodged in the inteſtines.

From the beginning of November to the end of December, aguiſh complaints, cholera, quincies, rheumatiſms, diarrhœas, beſides ſlow fevers, were common.

About

About the middle of December, the inſluenza broke out in Edinburgh, and, in a ſhort time, became ſo general that very few eſcaped the diſeaſe.

Besides the common ſymptoms, in the beginning of fevers, of a frequent pulſe, pain and lightneſs of the head, aching of the bones, ſhiverings, and the like, theſe fevers were attended, or uſhered in, with a conſiderable diſcharge of *mucus* from the noſe and tonſils, and a ſharp lymph from the eyes, inflammations of the throat, an inceſſant cough, and frequently with acute pains in the bowels, followed with looſeneſs and bloody ſtools *.

Before this fever affected the inhabitants of Edinburgh, the horſes had been univerſally attacked with the diſeaſe, manifeſting itſelf by coughs, and a copious diſcharge of acrid *mucus* from the noſtrils.

* For a further account of this diſeaſe, ſee Edin. Med. Eſſays, vol. 3. art. 2.

THIS is juſtly obſerved to have been the moſt univerſal epidemic on record; having, in the ſpace of three months, appeared in Germany, Britain, Flanders, France, Switzerland, Italy, and Spain *. It attacked Ireland ſomewhat later. It likewiſe broke out in the northern parts of America, about the ſame time as in Europe, travelling ſouthward till it reached the Leeward Iſlands.

THE effects of this conſtitution of the air ſeem not ſoon to have evaniſhed; for fevers of various kinds continued through moſt part of the year 1733, particularly the ſcarlet fever, attended with inflammations in the throat, vomitings and looſeneſs. Small pox were likewiſe frequent; which, towards the decline of the year, became very mortal.

IN

* I had not an opportunity of knowing the ſtate of the weather in theſe countries: but the ſame conſtitution of the air is known ſometimes to prevail over a great part of Europe; this however, paſſeth unnoticed, unleſs the attention of the public be attracted by ſomething extraordinary, as extreme colds, long and violent froſts, floods of rain, or the like.

In examining the epidemics from June 1735, which was the beginning of the other period remarkable for a defect of the higher winds, it appears that meaſles, gradually increaſing, became frequent in the country towards the end of that period. The meaſles were followed with dangerous and intractable coughs, peripneumonies, and diarrhœas: and numbers who had had the meaſles formerly were taken with a fever ſimilar to that of the meaſles.

In July, a fever of the ſlow kind prevailed, attended with a low pulſe, and diarrhœa, which appeared at one period or other of the diſeaſe. Afterwards the cholera and chincough became frequent both in town and country.

In December, the dyſentery began to ſpread.

From the end of the year 1735, till the following February, a low fever was common.

mon. In this diſeaſe, the patients, diſcovering at firſt great uneaſineſs and anxiety, ſoon became delirious, and were quickly weakened by ſymptomatic ſweats. With others this evacuation proved critical. A third claſs, with difficulty crept out of the diſeaſe without any ſenſible criſis.

In the month of February 1736, a fever prevailed in ſome parts of the country, ſaid to be of the pleuritic kind. But, notwithſtanding the pungent pain in the ſide, this fever ſeems, from the other ſymptoms, to have been of that ſpecies which proceeds from a reſolved ſtate of the blood, and which is frequently produced by that conſtitution of the air which generates putrefaction.

This fever was fatal to many; it was attended with bilious vomitings, and, though the pain about the ſhort ribs ſeemed to require bleeding, the patients did not well bear that evacuation; their thirſt, ſickneſs, and faintiſhneſs

faintiſhneſs being increaſed by it. The pulſe was neither frequent nor full, and ſunk immediately on bleeding. The blood was of a browniſh, yellowiſh, or greeniſh colour, and ſcarcely coagulated. The ſick were not ſenſible of ſleeping through the courſe of the diſeaſe, which was from 25 to 32 days.

THIS is a general account of the diſeaſes during, and for ſome time following, theſe two periods. When we compare the diſeaſes of the other periods of the five years with theſe, they will appear to have been neither ſo univerſal, nor ſo dangerous in their kinds. For, excepting a pleuriſy, in March 1732, the diſeaſes in the other periods were mild and tractable, and ſuch as did not indicate that conſtitution of the air which is productive of corruption, and which is ſo dangerous to animal bodies.

THAT the remote cauſes of the diſeaſes deſcribed above was not owing to any thing remarkable in the gravity, heat, or humi-

dity

dity of the air, will appear from the following mean ſtate of theſe three qualities, in each of the five years. For the differences, being inconſiderable, render it it improbable that they could have been productive of ſuch effects.

Mean height of the Barometer, Thermometer and Hygroſc. for five years *.				
Years, each from June to May, incluſive.		Barom.	Therm.	Hygr.
1731.	1732.	29.5.	11.4.	2.
1732.	1733.	29.7.	11.4	1.9.
1733.	1734.	29.6.	11.7.	1.7.
1734.	1735.	29.5.	11.1.	2.1.
1735.	1736.	29.6.	11.3.	2.1.

THE

* For the mean ſtate in each month, ſee the Med. Eſſays.

THE mean quantities of rain, in each of the laſt ſeven months for four years, is as follows.

1731.	1.943.
1732.	2.096.
1733.	1.76.
1734.	1.519.

THE regiſter of rain was not kept from June 1735.

WE frequently hear of the plague being tranſported from one place to another in the cargoes of ſhips, particularly in bale-goods. That infection hath been conveyed in this way, hath been ſufficiently aſcertained. But it may be doubted whether ſuch imported infection be very dangerous in the higher latitudes, eſpecially where the air of theſe climates is purified by high winds, which are frequent in mountainous countries. Even in the ſouthern countries of Europe, the devaſtation, that is ſome-

times made by that diſeaſe, ſeems to depend chiefly upon the conſtitution of the air at the time when the infection is communicated.

The great plague at Meſſina, in 1743, (which was the lateſt in Europe ſo far weſt as that city,) is ſaid to have been brought thither by a Genoeſe Tartana, and the great mortality in that place was believed to have proceeded wholly from this imported infection. But the rapid propagation of the diſeaſe ſeems to have been more owing to the ſtate of the air for ſome time before the arrival of that veſſel, and to a prediſpoſition in the bodies of the inhabitants to receive the infection, than to any other cauſe. In the hiſtory of that peſtilence, it is obſerved that ſouthern winds, and cloudy weather, had prevailed all that ſeaſon; and that the hahitants were thus rendered liable to catarrhs, ulcers and tumours about the glands of the throat and *fauces*, tumours in the parotid and inguinal glands, acrid humours in the

the lungs, and fevers of a bad kind *. From this we may judge how much the body was rendered ſuſceptible of new infection; and it is not improbable that the infection from the Genoeſe ſhip would have had but little, or no effect, had the air been purified by cool and dry north winds, inſtead of the long-continued warm and moiſt ſouth winds. It may be obſerved that the account of this ſtate of the air, and of its effects, coincides entirely with thoſe of Hyppocrates, and other authors living in theſe climates *.

* Speſſo dominarono torbidi, e nuvoloſi venti auſtrali. Avvicinoſſi indi l' equinozio della primavera dell' infauſto anno 1743, e poco men fredda eſſa moſtroſſi del traſcorſo inverno. Continuarono a ſpirare per lo più gli ſteſſi auſtrali venti, e ſi patirono non pochi, quaſi epidemiali catarri, che da qualche tempo in quà ſi ſono reſi ſoliti in ogn' anno. Fu però fatalità imperſcrutabile, come vedute ſi foſſero in tal tempo le dette innocenti malattie per alcuni accompagnate d' inſoliti accidenti, cioè, oltre della Toſſe, Raucedine, dolor de Petto, gonfiamento della Gola, e delle glandole del Collo, ed oltre l' Angine legittime, o ſpurie ne' pazienti, ſi viddero pur tumefarſi ad alcuni le glandole anguinali, e quelle, che ſon dietro l' oreochie dette Parotidi, e recavano anco Febri di mal coſtume. Memoria iſtorica del Contagio della Citta' di Meſſina, da Orazio Turriano. Cap. 3.

* Quum Auſter invaluerit, ejuſmodi in morbis contingunt, ulcera madentia, os præſertim, pudendum aliaſque partes occupant.

Now, though the diſeaſes of the two preceding periods might have proceeded from ſomething in the air too ſubtile for our inveſtigation, yet theſe few obſervations ſeem to be attended with ſo much probability as may at leaſt ſuffice to ſhew the impropriety of neglecting the degrees of winds in journals of the weather: ſince, in judging of the conſtitutions of the air, or in tracing the cauſes of diſeaſes from them, we cannot avail ourſelves of theſe journals, when thus defective; but may be miſled by them.

De Humoribus, ſect. 11.—and Rhazes to the ſame purpoſe; Ventus autem a polo veniens meridiano, corpora diſſolvit, ſenſus turbat, atque dolorem capitis et oculorum ægritudinem facit—febres itidem parit propter ſuam putredinem.—Eſt etiam plus omnibus ventis ægritudinem inferre paratus.—De ventis et aere, lib. 3. cap. 5.—This is the *auſtrina aeris conſtitutio* of the ancients, by which is frequently underſtood a warm and moiſt ſtate of the air, though without winds of any kind. This conſtitution of the air, with its effects, is thus deſcribed by Hoffman: Certiſſimæ experientiæ eſt, ſub diuturna humidaque auſtrina aeris intemperie, *præſertim ventis vacua*, magnam ad putredinem morborum generationem proclivitatem fieri: unde frequentius videmus, præcedente paulo longius taliſmodi aeris ſtatu, magno cum agmine prorumpere morbillos, catarrhales, malignas et petechizantes febres purpurataſque, &c.

FINIS.

Fig. 1.

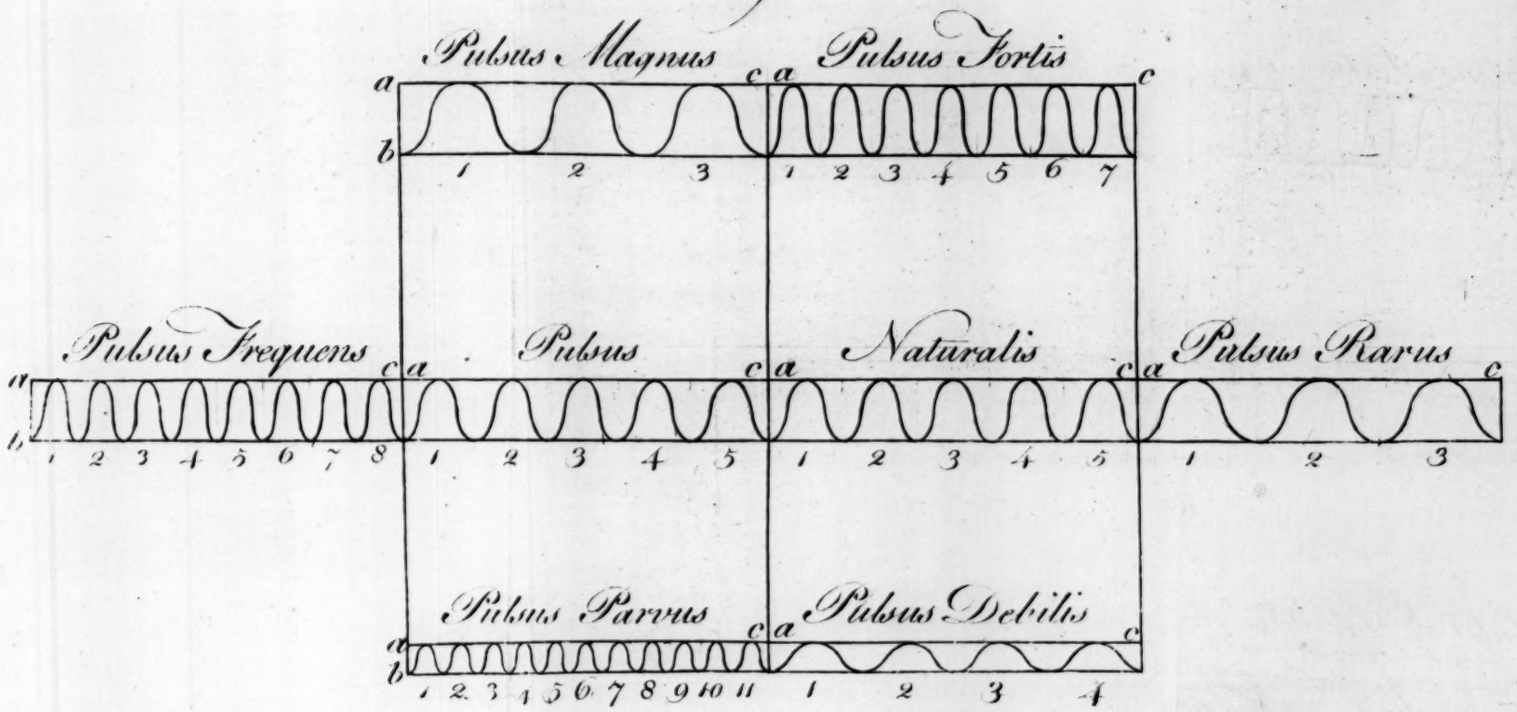
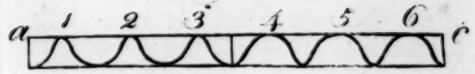

Pulsus Magnus
Pulsus Fortis
Pulsus Frequens
Pulsus
Naturalis
Pulsus Rarus
Pulsus Parvus
Pulsus Debilis

Fig. 2.



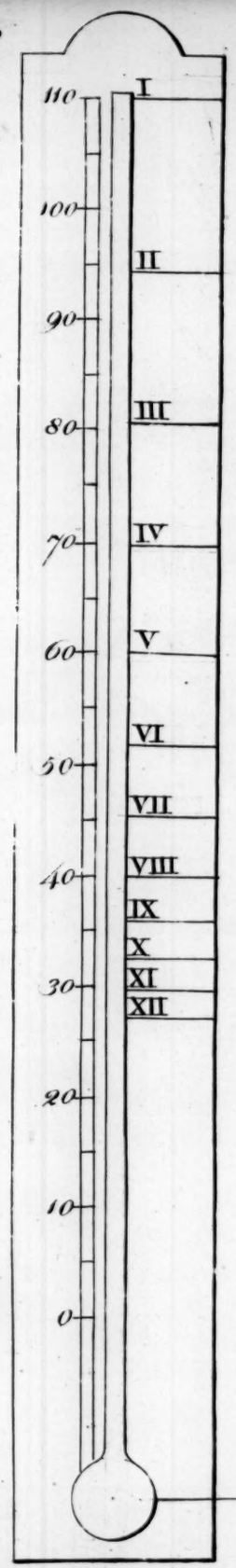


Fig. 1.

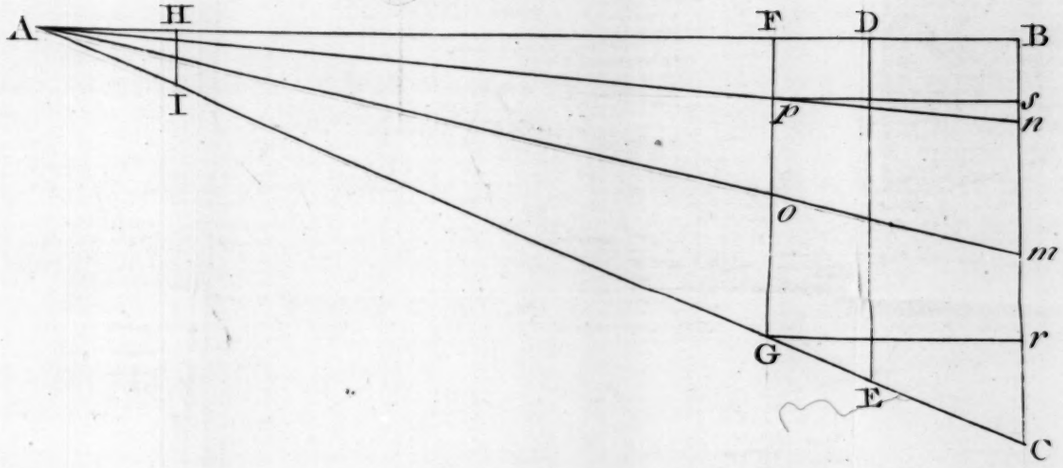


Fig. 3.

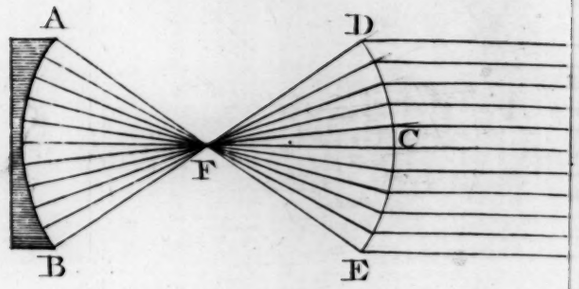


Fig. 2.

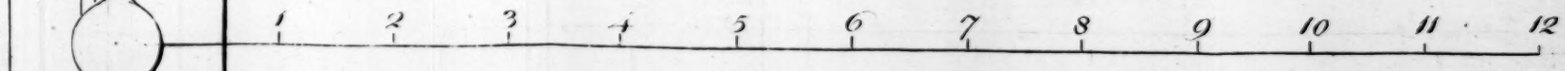
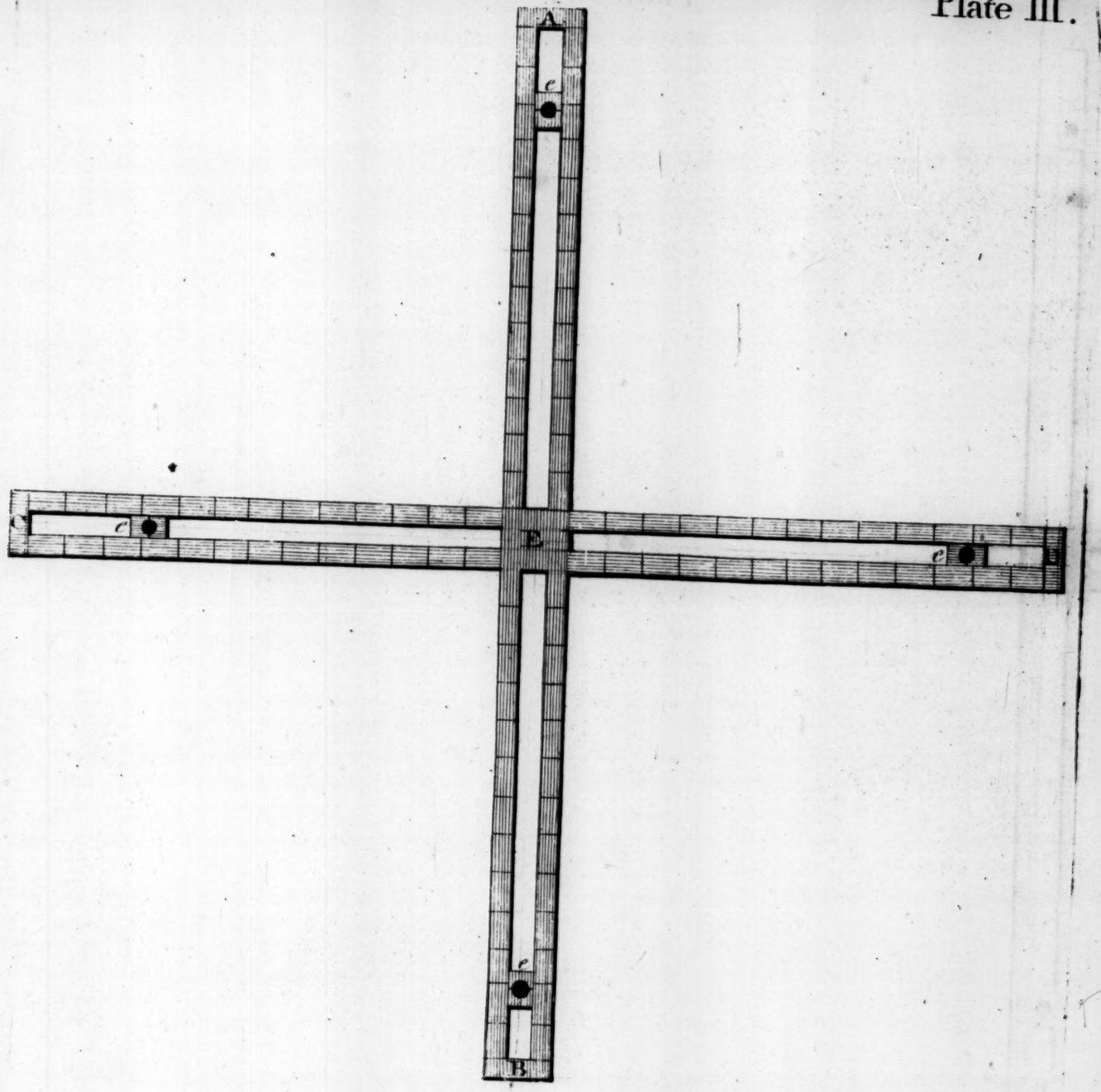
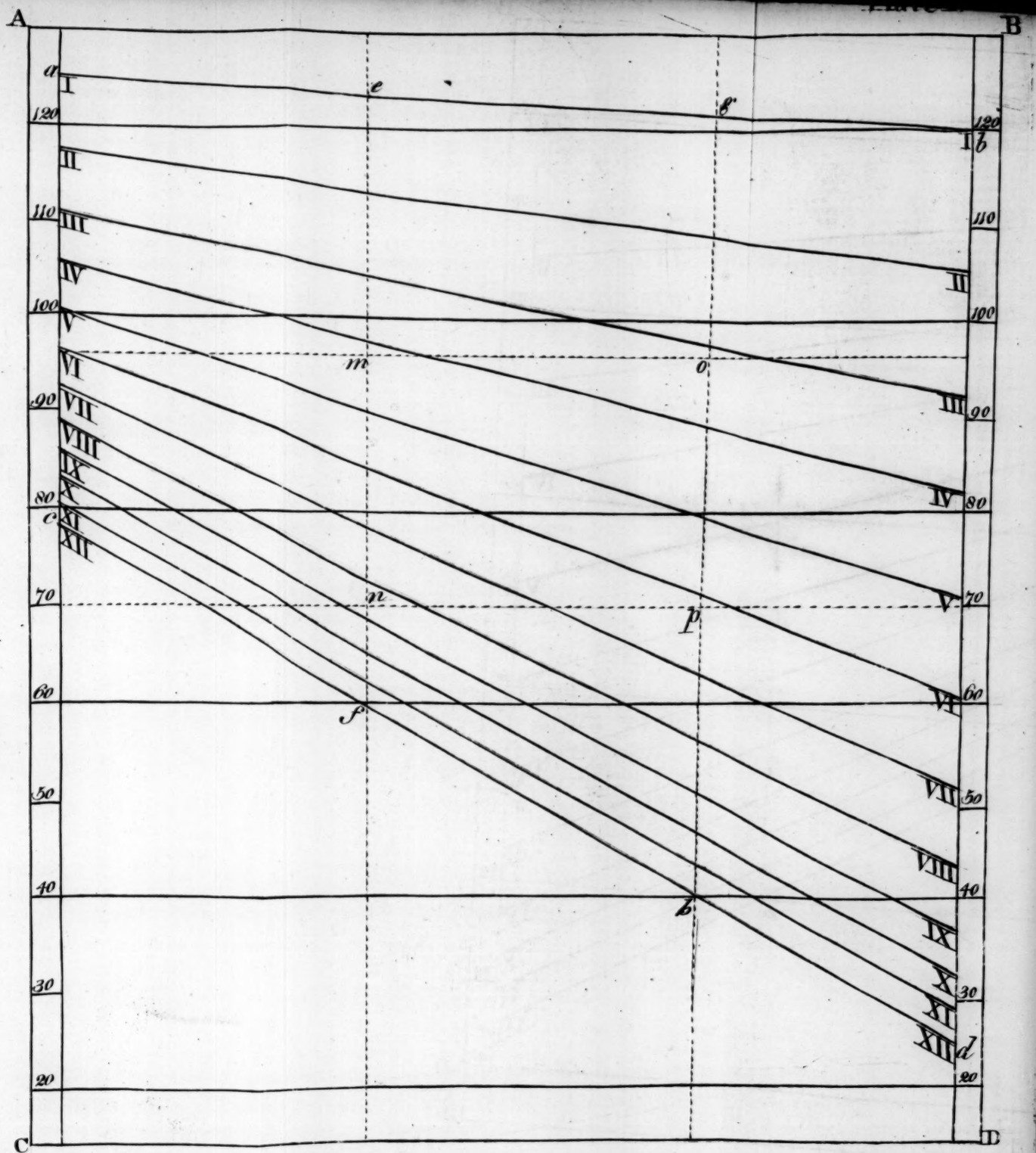


Plate III.




A
B
C
D
a
b
c
d
e
f
g
m
n
o
p
q
120
110
100
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I
II
III
IV
V
VI
VII
VIII
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X
XI
XII
XIII